STATIONARY PUMPS FOR FIRE PROTECTION

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1.0 SCOPE

1.1 General

This document provides guidelines for stationary pumps for fire protection. FM Global has adopted NFPA 20, ‘‘Stationary Pumps for Protection’’, 1999 edition, subject to interpretations, and/or comments as outlined in section 2.0, ‘‘Loss Prevention Recommendations’’. Included in section 2.0 are guidelines for fire pumps for high-rise buildings, and a listing of FM Global equipment alerts.

1.2 Changes from Previous Edition

Significant Changes Made in September, 2001 Revision.

1. The document has been reformatted to recognize NFPA 20, 1999 edition, with FM Global interpretations and/or comments referenced to that standard. NFPA 20 is no longer reprinted within this standard.

Significant Changes Made in January, 2001 Revision.

Data Sheet 3-7N, ‘‘Stationary Pumps for Fire Pumps’’, was updated to adopt the 1999 edition of NFPA 20. Specific items follow.

1. NFPA has changed the title to ‘‘Stationary Pumps for Fire Protection’’ since a new Chapter 5 has been added to cover positive displacement pumps for foam and water mist systems.

2. NFPA has added new definition in 1-8 relating to items covered in the new Chapter 5.

3. NFPA has added a new section 2-2.4 and associated Appendix item to discourage the use of pressure relief valves as part of system hydraulic design. An associated change has also been made as noted in Item 9 below.

4. NFPA has added a new second sentence to 2-6.1 to clarify the location of the circulation relief valve.

5. NFPA has added new sections 2-7.1.1 and 2-7.1.2 to clarify separation requirements for fire pump units.

6. NFPA has revised the second sentence of 2-9.3 to indicate that the water flow velocity limit applies only to that portion of pipe within 10 pipe diameters or the pump suction flange.

7. A new FM Global comment has been added after 2-9.6.3 discussing reasons from proper arrangement of elbows near the pump suction flange.

8. NFPA has revised 2-10.4 to clarify that a backflow preventer is acceptable in place of a check valve in the pump discharge assembly.

9. NFPA has revised 2-13.1 and A-2-13.1. The FM Global comments for this section have been revised accordingly, and now include guidance for booster pumps where static pressures may vary.

10. NFPA has revised 2-14.1.1 to clarify performance objectives.

11. NFPA has revised 2-21.3. Also, an FM Global comment has been added discussing the reason for the proper location of devices in the suction line.

12. NFPA has revised 3-1.1 and 3-2, and has included new figures and a chart showing the various types of pumps, to assist in proper understanding of the different types of pumps.

13. NFPA has revised 3-3.4. Also, an FM Global comment has been added after 3-3.4 discussing the reason for the proper location of devices in the suction line.

14. NFPA has revised 3-5.1 and 3-5.2 to differentiate separately coupled-type pumps from those that are not separately coupled.

15. NFPA has added a new chapter 5, ‘‘Positive Displacement Pumps,’’ which are used for foam and water mist systems. FM Global guidance for High-Rise Buildings has been relocated at the end of Chapter 4.

16. NFPA 20 reorganized Chapter 6. Existing FM Global comments have been retained in the appropriate sections. A new FM Global comment has been added after 6-2.1.

17. Various items in Chapter 7 have been revised, primarily relating to Approval (listing) requirements. Also, FM Global comment has been added after 7-3.4.2.

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18. NFPA has added and revised various items in Chapter 11 relating to positive displacement pumps.

Significant Changes Made in October, 1998 Revision.

Data Sheet 3-7N, *Centrifugal Fire Pumps,* was updated to adopt the 1996 edition of NFPA 20. Specific items follow.

1. 1-6. The term ‘‘Unit Performance’’ has replaced the term ‘‘Unit Purchase’’. Text has been changed to clarify that all components do not have to be purchased from a single supplier. An FM Global comment has been added to reinforce the existing concept that the pump manufacturer remains ultimately responsible for proper installation and performance.

2. 2-7. In the comment, the term ‘‘Except for installations made prior to 1978....’’ has been deleted. In A-2-7, the FM Global comment has been expanded to include criteria for pump rooms located within or attached to the building being protected.

3. 2-8.4. An FM Global comment has been added referencing Data Sheet 10-3, *Hot Work Management*.

4. 2-9.3. Additional information has been added to the FM Global comment. A table showing flows at 15 ft/sec (4.6 m/sec) for various pipe sizes has been added. Also, maximum friction loss guidelines for suction piping from a tank has been added to deal with situations of long suction pipes and/or multiple elbows and turns.

5. 2-9.6(c). This now allows elbows with plane parallel to pump shaft as long as elbow is 10-times pipe diameter from the flanges of the pump suction intake.

6. 2-9.9(a). NFPA 20 now allows two exceptions: a) check valves and backflow preventers are permitted in the suction piping when required by other NFPA standards or by the Authority Having Jurisdiction (AHJ), and b) flow control valves that listed for fire pump service and that are suction pressure sensitive are permitted where the AHJ requires positive pressure to be maintained in the suction piping.

Regarding item a), although nearly unanimous in opinion that check valves and backflow preventers belong on the discharge side of the pump, the NFPA 20 committee felt it necessary to recognize the reality that some water departments require backflow preventers on the suction suction side. In conjunction with this change, a new section 2-21 has been added at the end of Chapter 2 in NFPA 20 outlining correct installation on the suction side, including a requirement that the backflow preventers or check valves be at least 10 times diameter of pipe upstream from the suction inlet. An FM Global comment has been added stating that arrangements are acceptable if flow/pressure curve is satisfactory.

Regarding item b), this is consistent with FM Global comments now following A-2-1.2.

7. 2-13.1. Relief valves are no longer required for adjustable speed drivers, with the reason being that there will still be two safety devices; overspeed shutdown and engine governor.

The FM Global commentary for this section has been expanded to address the increasing intentional use of oversized pumps and relief valves to allow downsizing of sprinkler system piping and fittings.

8. 2-13.6. NFPA 20 deleted the exception to allow piping relief valves back to suction piping. While FM Global comments in Data Sheet 3-7N would allow this under certain conditions, the NFPA 20 committee cited the fact that pressure is not in fact relieved, and that relief valves are not designed for use in this way (effects of backpressure are unknown).

9. 2-22. NFPA 20 has added a section at the end of Chapter 2 requiring that all pumps, drivers, fuel tanks, controllers etc. be attached to resist 0.5G when local codes require seismic protection. FM Global comment refers to Data Sheet 2-8, *Earthquake Protection for Water-Based Fire Protection Systems*.

10. 3-1. NFPA 20 has eliminated the 500 gpm (1890 L/min) limitation for in-line and end suction pumps, which is consistent with existing Factory Mutual Research Approval guidelines.

11. 4-2.2.2. New FM Global text and associated figures have been added to provide Hydraulics Institute guidelines for design of wet pits.

12. NFPA 20 has deleted Chapter 5 on High Rise Buildings, citing that these installations are quite common and have no need for special attention or exceptions. NFPA 20 has reserved the space for use in the future for water mist and foam-water pump criteria now under development. Factory Mutual Research boldface guidance for high-rise buildings will continue to be included.

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13. Over the past several editions of NFPA 20, Chapter 6 covering the requirements for sources and transmission of electrical power to motors driving fire pumps have been completely rewritten to align with NFPA 70, ‘‘National Electric Code,’’ Article 695, ‘‘Fire Pumps,’’ as well as other articles where necessary.

FM Global comments from the previous Data Sheet 3-7N have been revised and deleted where necessary. Two specific additional FM Global comments are:

a) An FM Global comment has been added after A-6-3.1.2 to state that while circuit breakers within FM Approved controllers may be rated greater than 125% full-load motor current, feeders need not be similarly sized.

b) In the FM Global comment after 6-3.2, performance guidelines for reliable electric feed have been added.

14. NFPA 20, Chapter 8, ‘‘Diesel Engine Drive,’’ now allows the use of radiator-cooled diesel engines. While this is consistent with the current position in Data Sheet 3-7N, NFPA 20 has also incorporated more detailed guidance for ventilation in the pump house to ensure proper air flow for cooling of radiator cooled engines.

15. NFPA 20, Chapter 11, ‘‘Acceptance Testing, Performance and Maintenance,’’ now includes:

i) requirement that all wiring for the installation be completed and inspected by the electrical contractor prior to the initial startup and acceptance test.

ii) installation of an emergency power source for electric motor driven pumps must be installed and accepted in accordance with NFPA 110, ‘‘Standard for Emergency and Standby Power Systems,’’

iii) impeller replacement now requires a complete retest and performance equal to the original pump shop test required for all new pumps.

16. 11-2.7.1 now allows six starts and stops for acceptance instead of the previous ten. However, A-11-2.7.1 points out that other required tests accrue to these six, which will result in greater than six.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

The following general items relate to the general FM Global approach to NFPA standards. Specific comments and exceptions to NFPA 20 are addressed in section 2.2.1.

2.1.1 Shall versus Should

In most if not all instances the widespread use in the text of the mandatory shall, within an NFPA standard, can be replaced by the more permissive should. This is in keeping with other FM Global standards.

2.1.2 Authority Having Jurisdiction

There may be references in an NFPA standard to the term ‘‘authority having jurisdiction,’’ or other similar term. Legally, this could mean the state fire marshal, the local fire department, or some other state, municipal or governmental office. In the application of this data sheet, the reference is solely to FM Global unless the legal authority takes precedence.

2.1.3 Related NFPA or Other Standards

There may be a number of references to other NFPA or other non-FM Global standards. In many instances FM Global has a corresponding Data Sheet. FM Global Data Sheets will generally take precedence, unless those other standards have also been adopted by FM Global, either with or without interpretations.

2.1.4 Listed or FM Approved

Within the NFPA Standard, Listed means equipment Approved by Factory Mutual Research and listed in the Factory Mutual Research *Approval Guide*. Within other standards, similar terminology usually refers to a recognized testing laboratory.

Within the NFPA Standard, Approved means acceptable to the authority having jurisdiction. FM Approved equipment should be used whenever possible.

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2.2 Comments and Exceptions to NFPA 20

2.2.1 NFPA 20, "Stationary Fire Pumps for Fire Protection," 1999 edition

The NFPA 20, 1999 edition is adopted by FM Global. Section references to NFPA 20 are provided, followed by the FM Global interpretations and/or comments for that referenced section.

FM Global interpretations and/or comments are provided for the following sections of NFPA 20, 1999 edition.

1-6	2-9.3	3-1	6-1	7-5.2.4	9-1	10-1.2	11-2.6.2.1
2-1.1	2-9.5	3-2	6-3	7-5.4	9-4.2	10-1.3	11-2.6.3.3
2-1.2	2-9.6.3	3-3.4	6-3.1	7-7	9-5.2	10-2	11-2.7.3
2-1.4	2-9.9	4-1.1	6-3.2	8-2.6.4	9-5.2.4	11-2	11-4
2-3	2-13.1	4-2.1	6-5	8-2.6.6	9-5.2.7		
A-2.3	2-14.1.2	4-2.2.2	7-5	8-3.2	9-5.5		
2-7	2-19	4-3	7-5.2	8-4.5	9-6.7		
2-8	2-19.5	4-3.5	7-5.2.1	8-5.3	9-6.10		
	2-21	4-5.1.2		8-6.5			

Note that the following section numbers are referenced to NFPA 20, with the DS3-7N numbering format resuming with Section 2.3, "Fire Pumps for High Rise Buildings."

1-6 Unit Performance

The pump manufacturer shall be responsible for: 1) furnishing the complete unit consisting of pump, driver, controller, transfer switch equipment, and all necessary accessories; 2) ensuring proper installation and performance during pump acceptance tests; and 3) resolving all problems that may arise during installation and/or acceptance tests. Any sale or transfer of design, packaging or delivery of the unit does not relieve the pump manufacturer of its responsibility. If a pump physically leaves the manufacturer's facility with the FM Approval mark, it is implicit that any third party receiving the unit is an authorized representative of the pump manufacturer, and the pump manufacturer and the authorized representative shall assume the responsibilities described above.

2-1* Water Supplies

2-1.1 Reliability. No new cross connections between potable and nonpotable water supplies should be installed. Additional guidance regarding cross connections is contained in FM Global Data Sheet 3-3, *Cross Connections.*

2-1.2 Sources. Where an oversize pump has been installed, the pump should at least satisfy the water demand without drawing the residual pressure at the pump below the pressure allowed by the regulatory authority. A number of states and municipalities require a booster pump to reduce water output or shut off when the public water pressure at the pump suction reaches a predetermined residual. This is usually between 10 psi (69 kPa, 0.69 bar) and 20 psi (138 kPa, 1.4 bar). In these localities care should be taken to estimate correctly hose stream demands so that the pump output will not be affected due to low suction pressure and deprive the sprinklers of water.

Suction pressure regulating valves for booster pumps may be necessary to regulate residual pressure to a predetermined minimum required by a regulatory authority. A pilot-controlled valve modulates the pump discharge flow when the suction pressure varies. It reduces the pump discharge flow as the suction pressure approaches the preset minimum, so the pump does not cause the suction pressure to go below that for which the pilot control is set. Whatever water that is available at or above the pilot control setting is allowed to flow.

Unapproved pilot-controlled valves should be replaced with FM Approved models.

When pilot-controlled valves are installed (Fig. FM-A-2-1.2):

1. The suction pressure sensing line should not be less than ½ in. (12.7 mm) O.D. drawn temper copper tubing (ASTM Designation B88), or less than ½ in. (12.7 mm) nominal I.D. brass pipe (ASTM Designation B43).

2. The suction pressure sensing line should attach to the side of the pump suction pipe at a distance not exceeding 10 ft (3 m) from the booster fire pump inlet flange. A union with 3/32 in. (2.3 mm) orifice should be installed in the suction pressure sensing line between the strainer and drain tee.

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3. A brass body strainer with sediment blowoff should be installed in the suction pressure sensing line. The strainer should prevent the passage of foreign particles larger than 0.020 in. (0.5 mm).

4. If the suction pressure sensing line contains a shutoff valve, it should be an FM Approved indicating type, having bronze or brass body with brass, bronze, or stainless steel trim. The shutoff valve should be padlocked, or lock-wired and sealed in the open position. The ½ in. (12.7 mm) drain valve should be padlocked or lock-wired and sealed in the closed position.

5. They should be operated at least monthly by discharging water through a 2 in. (50 mm) or larger outlet. The valve position-indicator should be observed for proper valve operation.

6. To test the pilot-controlled valve 5, flow water from a 2 in. (50 mm) or larger outlet preferably located within the pump house. With water flowing, open the ½ in. (12.7 mm) drain valve 10 until pressure drops in the suction pressure sensing line 7 below the pilot control pressure setting. The pilot-controlled valve 5 should begin to close as soon as the pressure in the suction pressure sensing line is less than the pressure setting of the pilot control. Closing the ½ in. (12.7 mm) drain valve 10 should cause the pressure in the suction pressure sensing line 7 to increase and the pilot-controlled valve 5 to open.

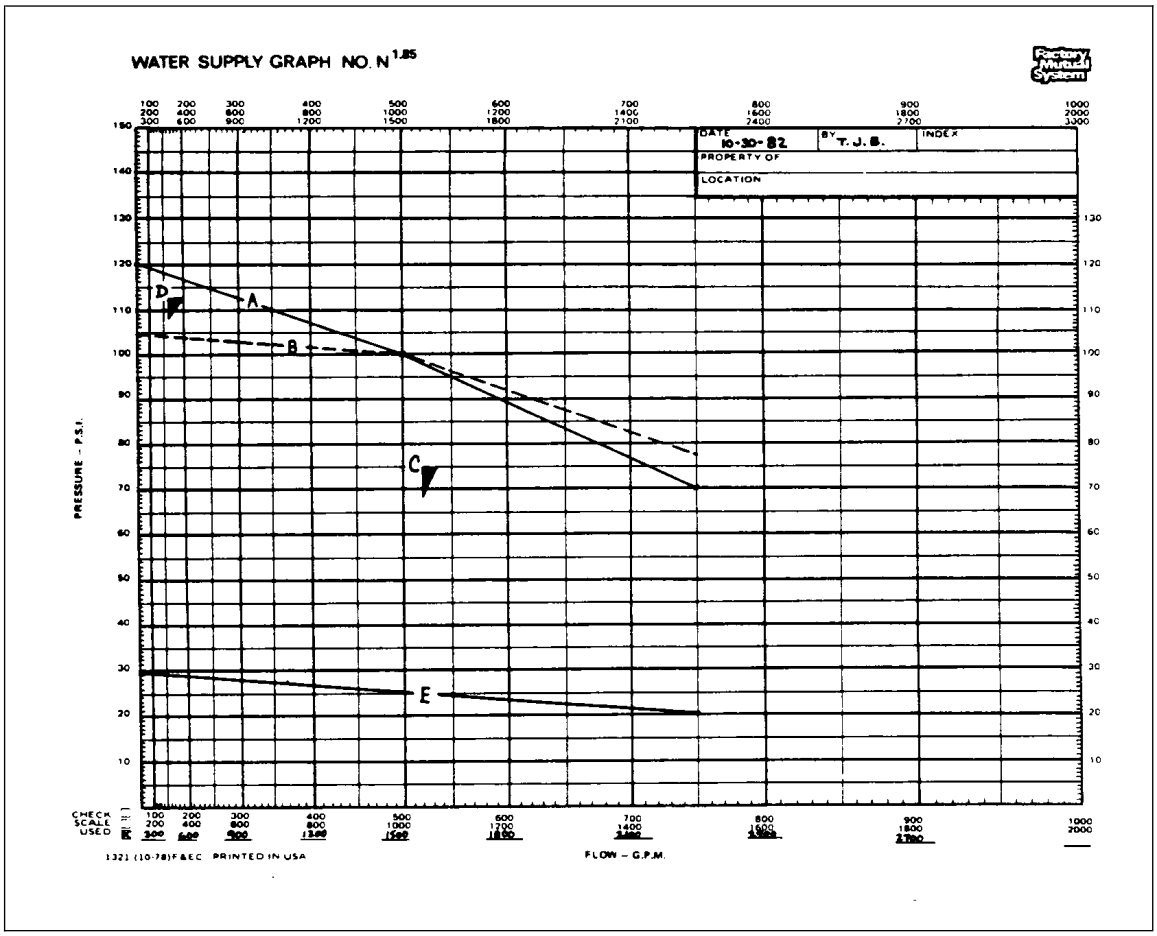

Fig. FM-A-2-3. Water supply graph.

2-1.4 Stored Supply. Stored water sources should be filled at a rate adequate to provide sufficient water storage within 8 hours to supply the demand the pump(s) is required to meet for the expected duration. In the event the stored source is oversized it should be filled to its capacity at a rate at least equal to the 8-hour rate established above.

2-3* Rated Pump Capacities. The capacity and pressure of a fire pump should be determined for each individual fire protection system after due consideration of all the factors involved. Where pumps are to supply automatic sprinklers and/or hose streams/hydrants, refer to FM Global Data Sheet 2-8N, *Installation of*

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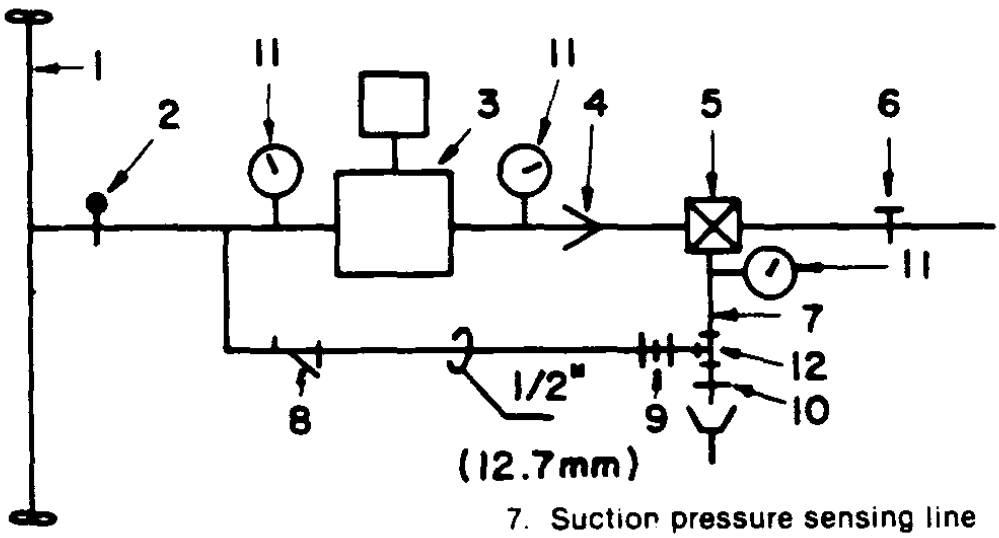

1. Public main
2. OS&Y suction valve
3. Booster pump
4. Discharge check valve
5. Pilot-controlled valve
(Install before or after discharge check valve.)
6. Discharge valve
7. Suction pressure sensing line
8. Strainer with sediment blowoff
9. Union with 3/32 in. (2.3 mm) orifice
10. ½ in. (12.7 mm) drain valve
11. Pressure gauge
12. Drain tee

Fig. FM-A-2-1.2 Arrangement for pilot-controlled hydraulically actuated minimum suction pressure regulating valve.

Sprinkler Systems, FM Global Data Sheet 4-4N, *Standpipe and Hose Systems*, and any relevant individual occupancy Data Sheet which addresses water demands for the occupancy(ies) involved.

A-2-3 The maximum pressure used in the design of fire protection systems supplied by fire or booster pumps should be pump rated pressure plus suction pressure at rated flow.

In Figure FM-A-2-3, Curve A represents the theoretical characteristic curve for a 1500 gpm, 75 psi rated horizontal fire pump taking suction from the source shown by E. Curve B is more typical of actual pump performance. Many pumps will not provide 120% of rated pressure at shutoff (churn). Demand point C represents a high volume, moderate pressure system. The demand can be supplied by the pump. Demand point D represents a low volume, high pressure system. The actual pump performance cannot meet the demand.

1 gpm = 3.8 litres/min

1 psi = 6.9 kPa = .069 bars

2-7 Equipment Protection

Automatic sprinklers should be provided in detached pump rooms of combustible construction and in internal combustion engine driven pump areas regardless of construction. Where the fire pump room is located within or attached to a building being protected, the pump room should be structurally strong enough to withstand anticipated fire exposure and impacts, be fully sprinklered, and have access from outside. Minimum fire rating of room construction should be at least 1 hour. In no case, should the fire pump room be located within or attached to an unprotected building.

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To lessen the likelihood of flooding, the pump house floor should be at or above the surrounding ground level.

2-8 Pipe and Fittings

Pressure sensing lines and fittings should be copper or brass.

2-9.3 Suction Size

The size of the suction pipe for single and/or multiple pumps should be such that the velocity does not exceed 15 ft/sec (4.6 m/sec) when the pumps are operating at 150% of rated capacity (see Table FM-2-9.3).

Table FM-2-9.3 Flow Required to Create 15 ft/sec (4.6 m/sec) Velocity

Pipe Size, in. (mm)	*Flow, gpm (L/min)*	*Pipe Size, in. (mm)*	*Flow, gpm (L/min)*
1 (25)	40 (151)	6 (152)	1320 (5000)
1 ½ (38)	95 (360)	8 (203)	2340 (8860)
2 (51)	155 (587)	10 (254)	3660 (13850)
2 ½9 (64)	225 (850)	12 (305)	5280 (19985)
3 (76)	350 (1325)	14 (356)	6330 (23960)
4 (102)	585 (2214)	16 (406)	8280 (31340)
5 (127)	940 (3560)		

Additionally, friction loss between any suction tank and pump suction inlet(s) should not exceed approximately 6 psi (0.4 bar), which will ensure adequate net positive suction head for conditions of a nearly empty tank. This will only occur in instances of long suction piping, or cases where there are many elbows of other fittings. Equivalent lengths for elbows and fittings should be included in calculations. C = 70 should be used in calculations.

2-9.5 Valves

The listed OS&Y gate valve should be the same size as indicated in Table 2-20 column headed ‘‘Suction (in.)’’.

It may be installed in the pump room on the inlet side of the eccentric suction reducer, if provided. [See Figure FM-A-3-3.1(a)].

The disc in a butterfly valve decreases the flow area in the valve body and necessarily provides an increased head loss compared with a gate valve of equal size. The disc inherently causes turbulence. For these reasons a butterfly valve should not be installed in pump suction piping.

2-9.6.3 As stated in the *Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps*, there is always an uneven flow in an elbow, and when it is installed in any position other than in a plane at right angles to the pump shaft of a horizontal split-case pump, this uneven flow causes more water to enter one side of the impeller than enters the other side. This causes a reduction in capacity and efficiency, as well as a thrust that may heat the thrust bearing and possibly cause rapid wear of that bearing. The unequal flow distribution may also cause impeller damage due to cavitation and/or flow separation. In cases where the elbow cannot be installed perpendicular to the plane of the pump shaft, a location 10 pipe diameters from the suction inlet is considered an acceptable distance to even out flow.

2-9.9* Devices in Suction Piping

Backflow preventers should be located on the discharge side of the fire pump whenever possible, due to the increased friction loss and the potential negative effect on pump performance.

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2-13.1 Relief Valve

Pressure Relief Valves for Adjustable-Speed Drivers

Note that for the NFPA 20 — 1996 edition, the requirement for a relief valve on pumps connected to adjustable-speed drivers was deleted on the basis of excellent field experience afforded by engine governors in combination with the overspeed shutdown feature included on FM Approved diesel-engines. Engines which are not equipped with overspeed shutdown should be provided with a pressure relief valve.

Pressure Relief Valves for Systems with Excess Pressure

The use of pressure relief valves should be avoided whenever possible by using proper system design techniques to ensure that the system will not experience excess pressure.

Generally, good design should dictate that the pump shutoff (churn) pressure plus static suction pressure not exceed the maximum pressure rating for system components, which is usually 175 psi (11.9 bar). For fire pumps taking suction from tanks or wet pits, such designs should be easily achievable. For booster fire pumps taking suction from public water supplies, such designs are achievable in most cases by the proper sprinkler system pipe sizing to minimize friction loss and the selection of a pump with a characteristic curve that most closely matches the system design requirements without causing excessive pressure under churn conditions. Designs which intentionally incorporate the use of smaller pipe and the use of a relief valve to truncate a portion or the water supply curve downstream from the fire pump should not be used.

2-14 Waterflow Test Devices

2-14.1.2 The piping arrangement shown in Figure A-2-14.1.2(b) should not be used. It does not test the suction water supply.

2-19 Pressure Maintenance (Jockey or Make-up) Pumps

When two or more fire pumps are installed, provide a separate jockey pump for each fire pump, with separate feeds and power connections.

2-19.5 Where emergency electric power is provided, the jockey pump motor should be connected to it.

2-21 Backflow Preventers and Check Valves

Backflow preventers should be located on the discharge side of the fire pump whenever possible, due to the increased friction loss and the potential negative effect on pump performance. Additional information is available in Data Sheet 3-3, *Cross Connections.*

3-1 General

The fire pump unit consists of the following.

Furnished by the pump manufacturer or his authorized representative:

1. Controller
2. Horizontal split-case pump
3. Driver and accessories
4. Flow meter or hose header and hose valves
5. Quality suction and discharge gages and connections
6. Pressure-relief valve and waste cone, when required
7. Automatic air release
8. Eccentric reducer
9. Increaser
10. Ball drip, when required
11. Circulation-relief valve, when required
12. Substantial bedplate for pump and driver
13. Pressure recorder
14. Flexible connections for engine cooling water and fuel lines.
15. Spare parts.
16. Instruction and maintenance manual in local language.

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Furnished by the purchaser, depending upon suction supply and type of driver:

1. Suction OS&Y valve
2. Discharge valve
3. Hose-connection valve
4. Discharge check valve
5. All piping connections
6. Suction screen to suit requirements
7. Wiring and power connection for electric motor
8. Pipe connections to steam turbine
9. Cooling-water overflow connection for internal-combustion engines
10. Discharge elbow or tee
11. Reducing tees or elbows.

3-2* Factory and Field Performance

Limited Service Fire Pumps furnish not less than 130% of rated capacity at not less than 65% of rated head. They are limited to maximum of 30 hp across-the-line squirrel-cage electric motor drive only.

3-3.4 Pipeline Strainer

Turbulent flow created by components located upstream from the pump suction inlet should be minimized so that pump performance is not compromised. The distance of 10 pipe diameters is considered by the water control industry as an acceptable distance.

4-1.1* Suitability

Pumps should be chosen for the conditions under which they will operate. Consideration should be given to the amount of water and pressures required at the pump discharge gage for automatic sprinklers and hose streams. (See Figure FM-4-1.1)

Vertical shaft pumps are particularly adaptable for installation on streams subject to flood flow. The use of these pumps is also recommended where an automatically controlled pump is desired and the physical conditions are such that horizontal-shaft pump would have to take suction under lift Since vertical-shaft turbine-type pumps do not require priming, their use under this condition eliminates the need for complicated automatic priming equipment.

The use of deep wells for direct fire pump service is undesirable if the maximum length of column pipe-and-bowl assembly would exceed 100 to 150 ft (30 to 45 m). Breakdown is more likely to occur with long shafts, and repairs would take more time. To meet the required ground-level pressure, the head rating of the pump would have to be increased; likewise, this would increase the horsepower capacity of the driver. Deep wells and long pump shafts usually increase significantly the total cost of the installation. Under these conditions, it may be more economical and reliable to provide aboveground storage tanks or reservoirs from which horizontal fire pumps could take suction. Deep well pumps of relatively low head and small capacity could be used for filling.

4-2.1 Source

Multiple pumps installed to meet the water demand should be far enough apart so that the water supply is adequate for all pumps to be supplied at 150% of rated capacity simultaneously.

The adequacy and dependability of the source of water are of primary importance and must be fully determined prior to the installation of the fire pump. Stored water supplies from lakes, streams, or open or closed reservoirs supplying wet pits are preferable. Groundwater supply from single well supplying fire service only is not acceptable.

Groundwater supply taken from thoroughly tested wells is acceptable for fire service when each of two wells alternately supplies the factory-use and fire pump water demand simultaneously. Each of the two wells should be equipped with an FM Approved vertical-shaft turbine-type pump having a flow and pressure characteristic suitable to meet factory-use or fire-service demand, whichever is higher. The combined capacities of the two pumps should be sufficient to supply factory-use and fire-service demands simultaneously.

4-2.2.2 Wet Pit Installations

See Figures FM A-4-2.2.2(a), FM A-4-2.2.2(b), and FM A-4-2.2.2(c).

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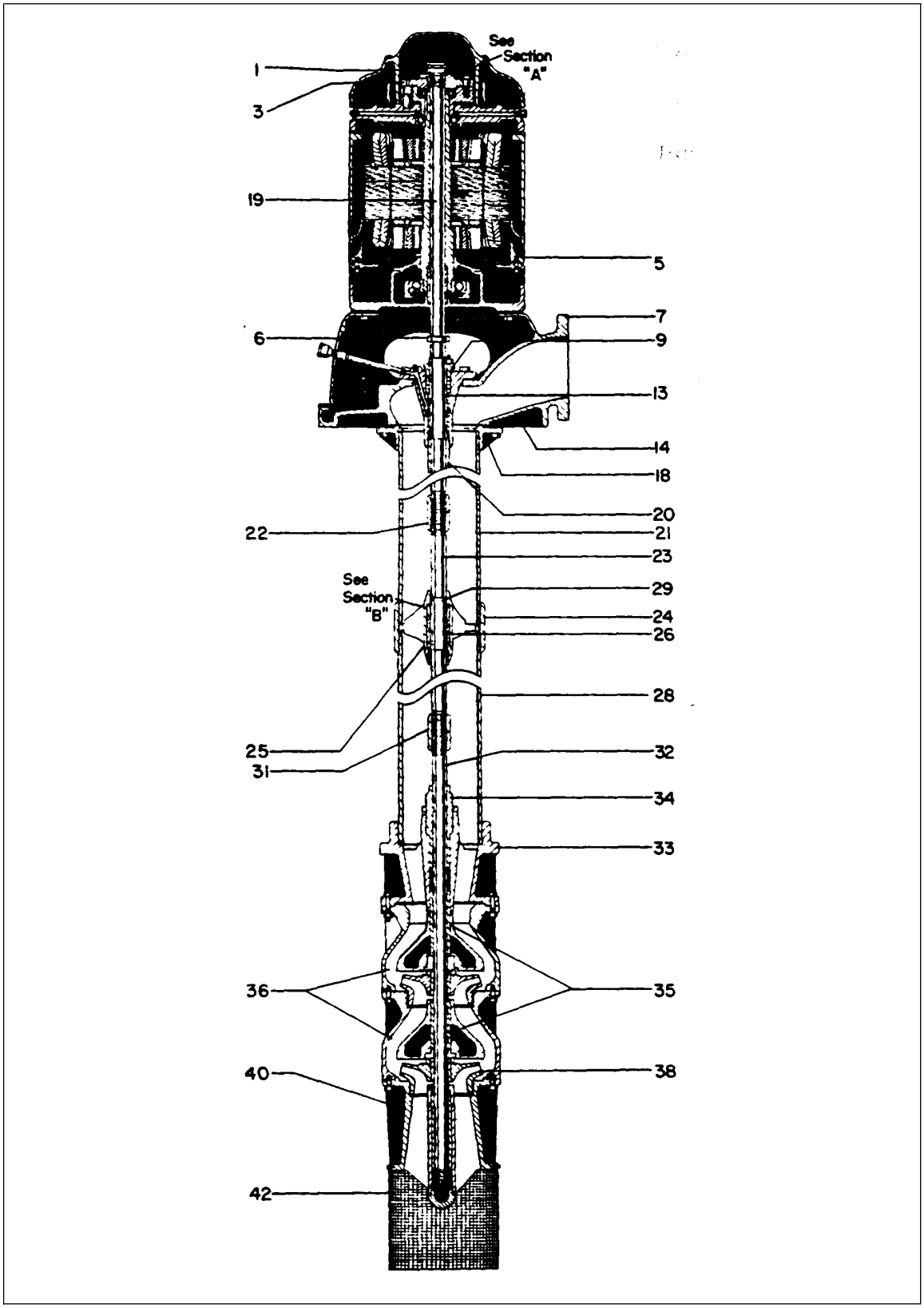

Fig. FM-4-1.1. Water-lubricated vertical-shaft turbine-type pump.

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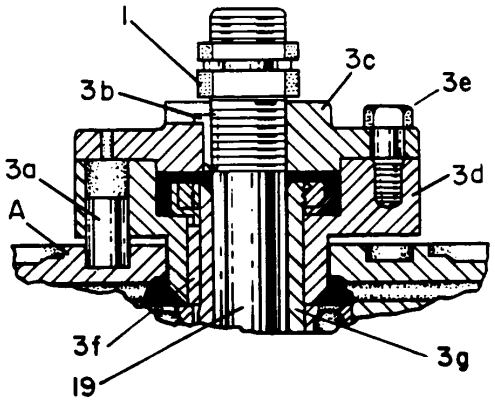
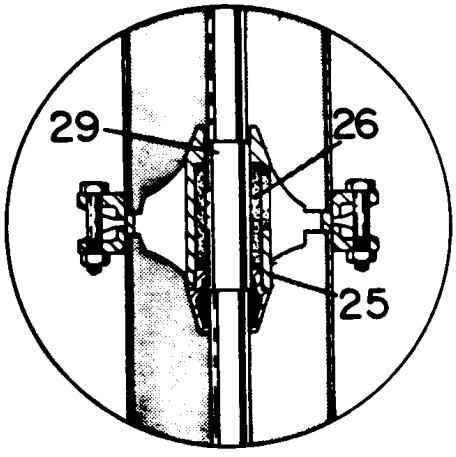


TYPICAL PIN-TYPE NONREVERSE RATCHET COUPLING

A. Ratchet plate. Stationary part of motor.
1. Top shaft adjusting nut.
3a. Ratchet pin. Engages slot in ratchet plate to prevent reverse rotation.
3b. Gib key. Keys top half coupling to top shaft.
3c. Top half coupling.
3d. Lower half coupling. Carries ratchet pins.
3e. Coupling drive bolt. Connects top half coupling with lower half coupling.
3f. Hollow shaft key. Connects motor hollow shaft to lower half coupling.
3g. Motor hollow shaft.
19. Top shaft.

Fig. FM-4-1.1. (cont.). Section A.



TYPICAL FLANGED COLUMN JOINT

25. Line shaft bearing retainer.
26. Line shaft bearing
29. Line shaft sleeve.

Fig. FM-4.1.1 (cont.). Section B.

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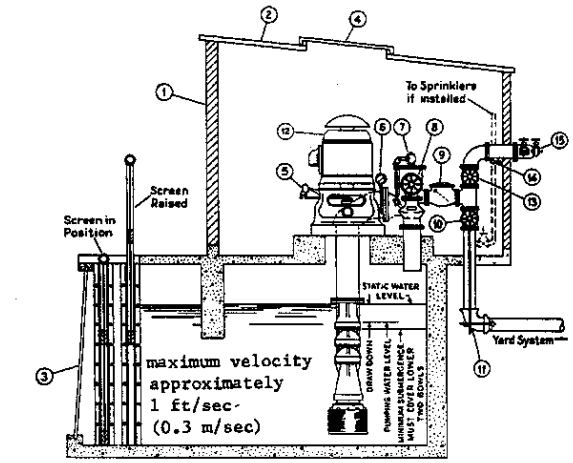

1. Suggested size of pump room for one pump 12 by 16 by 10 ft (3.7 by 4.9 by 3.0 m) high. Larger rooms for multiple-pump installations. Walls of noncombustible construction: brick, tile, concrete, or corrugated asbestos on steel frame (last suitable only where climate makes heating unnecessary). Floor of concrete.
2. Noncombustible roof; otherwise install sprinklers.
3. Trash rack, ½-in. flat or ¾-in. round steel bars spaced 2 to 3 in. apart.
4. Roof hatch
5. Solenoid oil valve; oils line-shaft bearings, when required
6. Discharge gage
7. Automatic air release
8. Pressure-relief valve, waste cone, and waste pipe, when required
9. Discharge check valve
10. Discharge valve
11. Discharge pipe
12. Vertical hollow-shaft electric motor or approved right-angle gear
13. Hose-connection valve
14. Ball drip, when required
15. Approved flow meter or hose header and hose valves

Fig. FM A-4-2.2.2(a) Vertical-shaft turbine-type fire pump installation with section from wet pit.

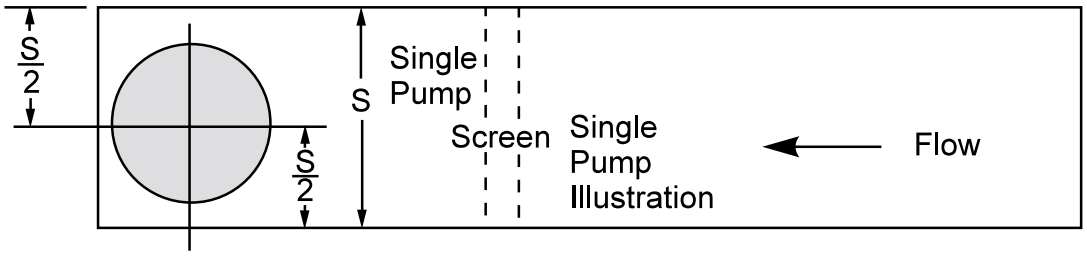

Fig. FM A-4-2.2.2(b) Sump dimensions plan view.

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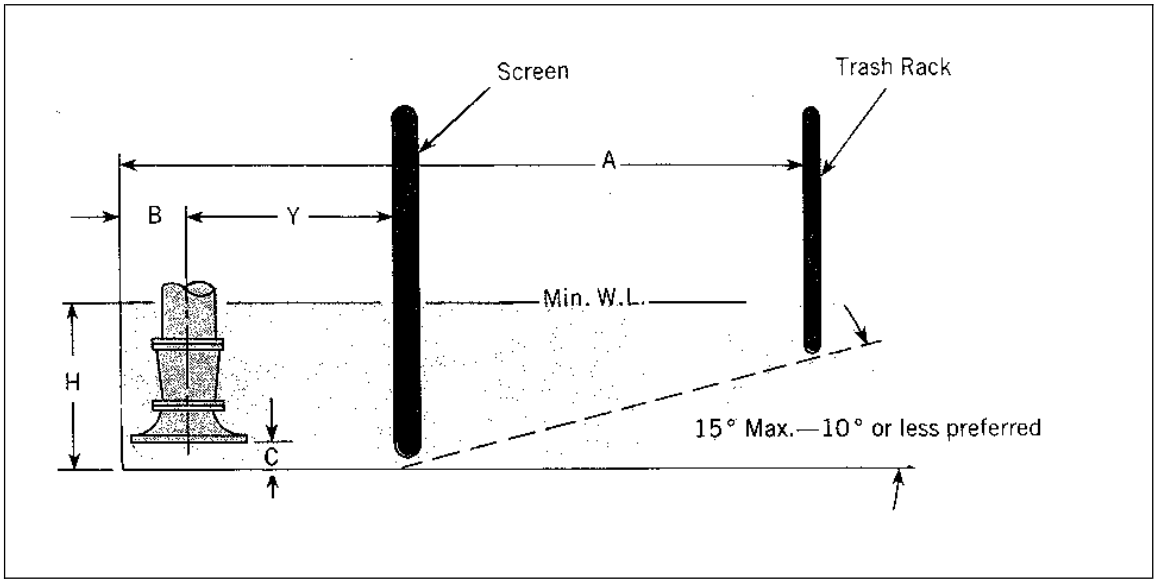

Fig. FM A-4-2.2.2(c) Sump dimensions elevation view.

Figures FM A-4-2.2.2(b) and FM A-4-2.2.2(c) illustrate dimensions recommended by the Hydraulics Institutes Standards for intake design using sump (wet pit).

Variables are as follows:

S — this is the minimum width of the wet pit.
B — this is the suggested maximum dimension of the pump centerline from the back wall. The edge of the bell should be close to the back wall.
C — should be specified by the pump manufacturer.
H — this is minimum value based on minimum water level. Submergence for determining the location of the second impeller from the bottom of the pump bowl assemble is H minus C.
Y — this is minimum recommended distance of the pump centerline to the screen.

Based on expected maximum pump flow, recommended values are as follows:

Pump flow, gpm (l/min)	*S, in. (mm)*	*B, in. (mm)*	*Y, in. (mm)*
Up to 3000 (11,400)	34 (864)	13 (330)	60 (1524)
4000	40 (1016)	16 (406)	70 (1778)
5000	44 (1118)	18 (457)	75 (1905)

Note: that other values may be used when recommended by the pump manufacturer or when alternate designed are certified as being in accordance with the design principles in the *Hydraulic Institute Standards*.

When determining dimension S in order to not exceed 1 ft/sec (0.3 m/sec) velocity in the wet pit, dimension H will be fixed, and S should be either the minimum indicated above, or larger if needed to not exceed the velocity limits. Use the minimum low water level in the pit for this determination.

4-3 Pump

Fire-Pump Unit. The fire pump unit consists of the following.

Furnished by the pump manufacturer or his authorized representative:

1. Controller
2. Vertical-shaft turbine-type pump
3. Column Pipe
4. Line shaft
5. Driver and accessories

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6. Surface of underground discharge head
7. Flow meter or hose header and hose valves
8. Suction strainer
9. Automatic air-release valve and fittings
10. Quality discharge pressure gauge
11. Pressure-relief valve and waste cone when required
12. Water-level indicator when required
13. Pressure recorder
14. Flexible connections for engine cooling water and fuel lines.
15. Spare parts.
16. Instruction and maintenance manual in local language.

Furnished by the purchaser, depending upon suction supply and type of driver:

1. Discharge valve
2. Hose-connection valve
3. Discharge check valve
4. All piping connections and fittings
5. Suction screen to suit requirements
6. Wiring and power connection for electric motor
7. Pipe connections to steam turbine
8. Cooling-water overflow connection for internal-combustion engines

4-3.5 Fittings

Discharge Pipe. The size and type of the discharge pipe and its check valve and FM Approved indicating valve should be as detailed in Section 2-10 of NFPA 20.

Pressure Gage. The pressure gage should be connected near the discharge tee or elbow.

4-5.1.2 Nonreverse ratchets supplied as an integral part of vertical hollow-shaft motors are capable of withstanding full voltage starting torque of the motor if power phase reversal occurs for any reason. (See Figure FM-4-1.1.)

A vertical shaft turbine-type pump should not be allowed to rotate in the reverse direction because of the possibility the line shaft will unscrew at one or more line-shaft couplings.

6-1 General

The electrical equipment should conform to the National Electric Code, Canadian Electric Code, British Standard Code of Practice, or other local codes as required.

When expansion or occupancy changes in plants having an electric-motor-driven fire pump require the installation of a second fire pump, consideration should be given to installing pump driven by a diesel engine.

6-3* Power Supply Lines

The pump circuit between its entrance to the site and the pump room should preferably be buried. However, when properly protected against damage by fire, wind, or lightning, it may be acceptable to locate this circuit 1) in rigid steel conduit on the outside of an exterior wall of fire-resistive building, 2) in a conduit over or inside a fire-resistive building having noncombustible occupancy, 3) in messenger-supported cables or open wire over the roof of fire-resistive building having noncombustible occupancy, or 4) overhead on poles in the plant yard where not exposed to potential damage from storage or operations. In no case should the circuit be routed over or through either a combustible building, or any building with combustible occupancy.

Nonarmored cables designed for direct burial in the earth are acceptable without being installed in conduit if buried at least 24 in. (0.6 m) deep. This depth may be reduced to 18 in. (0.5 m) or less provided supplemental protective covering such as 2 in. (51 mm) concrete pad, metal raceway, pipe or other suitable protection is used. Armored cables do not ordinarily require additional protection against mechanical injury. See NFPA 70-1996, National Electric Code, section 300-5.

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6-3.1* Circuit Conductors

NFPA 70, Article 430, Part B, Motor Control Circuits, requires conductor sizing to be rated for at least 125% of motor full-load current rating. Larger sizes are not needed unless required to meet provisions of NFPA 20 section 6-3.4. Any NFPA 20 Chapter 7 requirements for rating of controller components should not be interpreted to require a similar rating for conductors.

6-3.2 Power Supply Arrangement

The intended performance guidelines to ensure a reliable electrical feed are that the electrical feeds should:

1. not be exposed to direct damage from fire/explosions, or from any equipment or other processes that are part of the plant's normal operations, including any exposures within the site location that could damage the feed,

2. not be exposed to electrical/mechanical problems created by non-fire protection equipment connected to the same feed (note that electrical/mechanical problems for the fire protection equipment itself is already covered by the various requirements in the relevant Approval Standards), and

3. Be arranged so that disconnection will not be made during fire event by plant staff, fire department, or others.

The primary fuses that protect transformers supplying power to the motor should be so rated as not to open under locked-rotor current of the motor in addition to any plant load for an indefinite period.

Ground-fault protection (circuit-interrupter) should not be installed in any portion of the circuit (service, transformer, or feeder) which supplies power to the fire pump controller, including the electric utility. If the ground fault protection must be provided, it should be set above the motor locked rotor current, and also set so that it will not operate on motor start-up.

Feeder Overcurrent Protection. Separate overcurrent protection is not required for the fire pump feeder. Experience shows that short circuits are unlikely to occur in properly arranged fire pump feeder, and such protection is usually omitted to eliminate another possible source of trouble that may interrupt the power supply to the fire pump. If short circuit should occur, protective devices farther back on the system will usually clear it. However, local authorities sometimes require separate overcurrent protection for the feeder, or the owners desire it for more precise protection of lone, expensive feeder. In this event, an air circuit breaker should be used. It should have an interrupting rating sufficient to withstand the maximum short-circuit current available at the point of connection to the power system.

If a manual disconnect switch or overcurrent protective device is provided in the fire-pump feeder circuit, it should be in a locked box or cabinet, or otherwise locked in the closed position. The box, cabinet or switch should be clearly identified FIRE-PUMP FEEDER CIRCUIT.

If the plant power supply is through local transformers and the main switchboard for the plant load is exposed to damage by fire, the fire pump feeder should be connected to the secondary leads of the transformers ahead of all disconnecting means. If the main switchboard is not exposed to damage by fire, this circuit may be taken from the main switchboard if connected ahead of all circuit breakers or fuses in the secondary circuit.

A means for disconnecting the plant circuits from the power supply should be provided, located so as to be accessible in event of a fire in the property protected or in exposing property.

6-5 Motors

Where the motor is supplied from 208-A or 416-volt system, motors designed for these voltages should be used.

Motors should be made according to specifications of the National Electrical Manufacturers Association (NEMA) or Canadian Electrical Manufacturers Association (CEMA).

The horsepower ratings of motors having a temperature-rise rating other than 40°C, or not having specified service factor, or having a service factor of 1.0 should at least equal the maximum brake horsepower needed to drive the fire pump at the pump maximum load condition, even if that occurs at a flow point beyond 150% of the pump rating.

7-5 Starting and Control

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Starting and Stopping. Fire pump and booster pump units supplying water to sprinklers and hoses should be arranged for automatic starting and manual stopping. The intent of manual stopping is that whenever the pumps starts, the pump house should be visited by appropriate personnel to determine that the pump unit is running properly, and to make sure that the pump is not stopped until it is ascertained that pump starting causes have returned to normal and that any fire emergency has been successfully resolved.

A fire pump or booster pump unit should not start frequently to maintain pressure in the fire protection system. However, it should start as soon as a dry pipe, preaction or deluge system has tripped, or one or more sprinkler heads on wet pipe system has operated. Where there is more than one such unit, the starting pressure should be approximately the same.

FM Approved Manual Controllers. Motor Starter. The manual motor starter has an external handle that moves in one direction only from the initial to the final position. This handle closes the motor circuit switching mechanism mechanically, without dependence upon any electrical-control circuits, magnets or equivalent devices.

The motor starter returns automatically to the OFF position if the operator releases the starter handle in any but the full running position. The only exception to this is in the case of the primary-resistance type where overheating by the starting current is prevented by other acceptable methods.

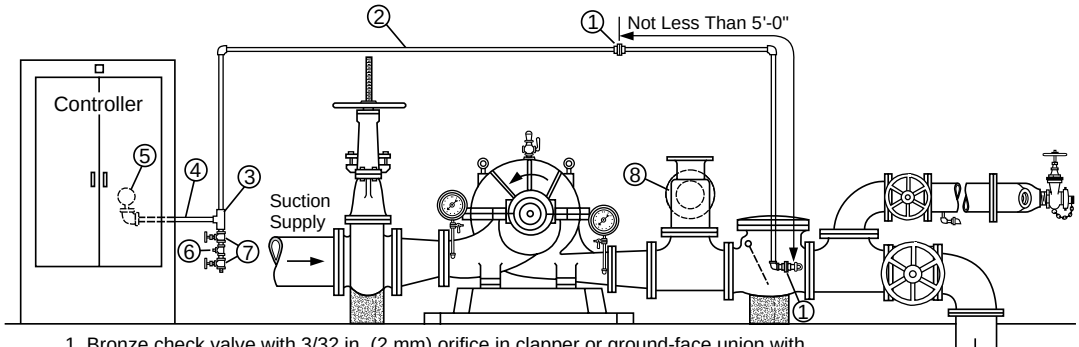
In addition (except where a circuit breaker is used to start the motor), means is provided in the controller for electrically starting and stopping the motor. Additional control stations for starting the motor may be provided at locations remote from the controller, but such stations should not be operable to stop the motor.

7-5.2 Automatic Controller

Fire pump units may be controlled automatically by a predetermined change in water pressure, by water flow, or by combination of these two factors. Control by water pressure is most common. If the fire pump unit is to be started automatically by a change in water pressure, an FM Approved combined manual-and-automatic controller should be used. The controller should be arranged so that it starts the pump unit automatically and permits it to run until it is show down manually.

7-5.2.1

See Figure FM-A-7-5.2.1. Use this arrangement for piping to pressure switch.



1. Bronze check valve with 3/32 in. (2 mm) orifice in clapper or ground-face union with noncorrosive diaphragm having 3/32 in. (2 mm) orifice
2. Not less than 1/2 in. (13 mm) brass pipe or copper tubing and fittings located outside controller
3. 1/2 by 1/2 by 1/4 in. (13 by 13 by 6 mm) tee
4. 1/4 in. (6 mm) brass pipe
5. Pressure switch
6. 1/2 by 1/2 by 1/4 in. (6 mm) opening for test gage plugged
7. 1/2 in. (13 mm) globe valves for testing automatic mechanism of controller
8. Relief valve

Fig. FM-A-7-5.2.1 Acceptable piping connection for automatic fire pump control by system pressure.

Water Pressure Control. The pressure switch should be specifically listed for fire pump service.

Fire Pump Settings [from NFPA 20 Section A-11.2.6(d)]. The fire pump system, when started by pressure drop, should be arranged as follows:

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1. The jockey pump stop point should equal the pump churn pressure plus the minimum static supply pressure.

2. The jockey pump start point should be at least 10 psi less than the jockey pump stop point.

3. The fire pump start point should be 5 psi less than the jockey pump start point. Use 10 psi increments for each additional pump.

a) Each controller for multiple pump installations shall have its own individual pressure sensing line.

b) The pressure sensing line connection shall be made between the pump discharge check valve and the discharge control valve.

4. Where minimum run times are provided, the pump will continue to operate after attaining these pressures. The final pressures should not exceed the pressure rating of the system.

5. Where the operating differential of pressure switches does not permit these settings, the settings should be as close as equipment will permit. The settings should be established by pressures observed on test gauges.

6. Example:
Pump: 1000 gpm, 100 psi pump with churn pressure of 115 psi.
Suction Supply: 50 psi from city-minimum static.
60 psi from city-maximum static.
Jockey pump stop = 115 + 50 = 165 psi
Jockey pump start = 165 — 10 = 155 psi
Fire pump stop = 115 + 50 = 165 psi
Fire pump start = 155 — 5 = 150 psi
Fire pump maximum churn = 115 + 60 = 175 psi
(For SI units: 1 psi = 0.0689 bar.)

7. Where minimum run timers are provided, the pumps will continue to operate at churn pressure beyond the stop setting. The final pressures should not exceed the pressure rating of the system components.

If the fire pump unit is started automatically by waterflow, an FM Approved manual controller (except the straight mechanically operated type) may be used. These controllers either have relay for remote control by waterflow or may be ordered with this relay. Some FM Approved manual controllers have the waterflow control circuit so arranged that the motor will start when this circuit is opened and will run continuously until shut down manually. These controllers are suitable for use with any FM Approved waterflow device. Other FM Approved manual controllers start the motor when this control circuit is opened and stop it when the control circuit is again closed. They are suitable only for use with dry-pipe or deluge valves. The circuit to waterflow devices should normally be closed and should be electrically supervised.

Automatic control of the motor should be by waterflow instead of water pressure under the following conditions.

a) Where the water pressure fluctuates so much that a satisfactory cut-in pressure cannot be obtained.

b) Where the hydraulic conditions and pump location are such that the opening of a moderate number of sprinklers does not cause an appreciable drop in pressure at the pump.

c) Where the pressure of the water supply is satisfactory for ordinary occupancies but a hazardous occupancy area makes an immediate increase in water pressure desirable should one or more sprinklers be opened by a fire in the hazardous area.

See Section 2-5 for pressure recorder recommendations.

7-5.2.4 Sequence Starting of Pumps

See FM Comment after Figure FM-A-7-5.2.1. Delay stating an electric motor driven pump only if the capacity of the power supply conductors are not large enough to accommodate starting more than one pump simultaneously.

7-5.4 Methods of Stopping

Stopping should be manual.

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Setting the run period timer to ‘‘Zero’’ is not an acceptable means of converting from automatic stop to manual stop. Approved methods for achieving this conversion are listed in the Factory Mutual *Approval Guide* for each controller equipped with run period timer.

Some controllers, when arranged for manual stop, and with the run period timer set at ‘‘Zero’’, are subject to cycling under the dictates of the pressure switch.

Run period timers should be checked regularly to insure they are set at not less than two to three minutes to prevent cycling.

7-7 Limited Service Controllers

Limited service controllers should not be used with standard fire pumps.

Limited service controllers do not contain an isolating switch and substitute thermal-element type circuit breaker with a relatively low current-interrupting rating for magnet trip-type circuit breaker. In most cases the lack of an isolating switch does not allow the limited service controller to qualify as service entrance equipment as does the standard motor controller. A thermal-element type circuit breaker is affected by ambient temperature, and as such, does not have a uniform current carrying characteristic.

8-2.6.4* Heat Exchanger Water Supply Bypass

The maximum pressure allowable on the cooling line should be indicated on the pressure gauge. When the pressure regulator is bypassed, the pressure should not exceed the maximum allowable pressure. Heat-exchanger-cooled engines are equipped with an engine-driven pump which circulates coolant around the heat exchanger tubes and through the engine block. Only clean or treated coolant complying with the engine manufacturer’s recommendation should be used in the circulating system. The coolant temperature is regulated by thermostat in the circulating system.

Raw water for the heat exchanger is piped from the fire pump through connection between the pump outlet and the discharge valve. The raw-water line is equipped with strainer, control valves, bypass, and gage connection. When the heat-exchanger tubes are not designed to withstand 300 psi (2067 kPa, 20.7 bars), regulator is provided in the raw-water line. When the pump is arranged for automatic starting, the raw-water line is equipped with a normally closed solenoid valve that opens only when the engine is running; otherwise, water from the suction tank or reservoir could be wasted through the pump and engine-cooling system.

A solenoid valve is not required when the pump is vertical-shaft turbine type installed in a well or wet pit.

Engine-exhaust manifolds which are cooled with water have water jackets connected into the circulating cooling system or into the raw-water discharge line from the heat exchanger. Oil coolers, intake manifolds and other parts may also be equipped with water jackets supplied from the cooling system, as recommended by the engine manufacturer.

Engines require a flow of 15 to 65 gpm (56.8 to 264 dm^3/m), or more, of raw water through the heat exchanger for adequate cooling. The raw-water outlet should discharge freely to atmosphere in a location visible to the operator, usually the waste cone of the pump relief valve.

8-2.6.6 Radiators

Radiator Cooled Engines. Coolant in radiator-cooled engines is circulated through the engine block and the radiator by an engine-driven pump. Only clean or treated coolant complying with the engine manufacturer’s recommendation should be used in the circulating system. The coolant temperature is regulated by thermostat in the coolant system.

Combustion and cooling air should be obtained from outside the pump room through free-swinging louvers having an effective net area of at least two times the area of the radiator air outlet.

A pusher-type, engine-driven fan draws ambient cooling air over the pump and engine and forces it through the radiator.

Cooling air from the radiator should be ducted to outside the pump room through free-swinging louvers having an effective net area of at least one and one-half times the area of the radiator air outlet. See Figure FM-8-2.6.6.

Radiator-cooled engines require much more cooling air than comparably rated heat exchanger-cooled engines.

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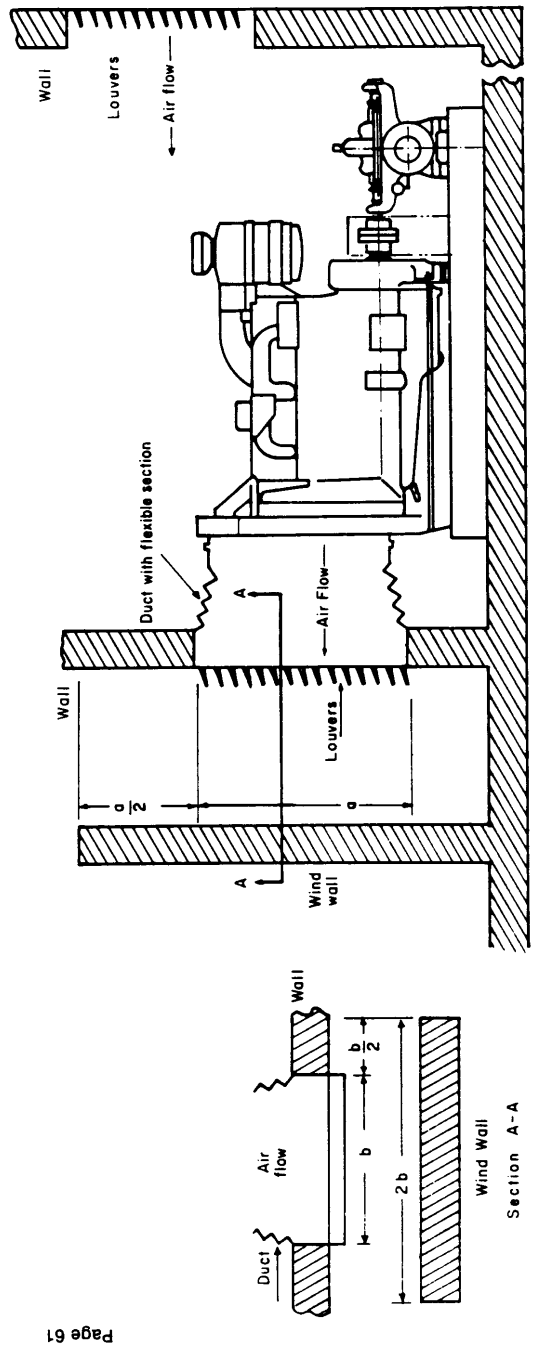

Section A-A

1. The pump-house wall air inlet should be at least 2 times the area of the radiator.
2. The pump unit should be installed so cooling air flow is in the same direction as the prevailing winds. If the engine-mounted fan must push against the prevailing winds, a wind wall should be built about 3 feet (0.9 m) from the pump-house wall outlet.
3. Install the radiator close to the pump-house wall outlet to minimize necessary ducting but allow enough room for servicing. Ducting may be sheet metal or canvas. If sheet metal is used, a canvas joint between the ducting and radiator is necessary for vibration isolation.
4. The pump-house wall air outlet should be at least 1½ times the area of the radiator.
5. A liberal factor of safety should be used when calculating the area of the pump-house wall air inlet or outlet.
6. Louvers should be used in the pump-house wall air inlet and outlet to prevent outside air, rain, and snow from entering the pump house when the engine is not operating.

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Fig. FM-8-2.6.6 Typical radiator-cooled engine installation.

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A thermostatically controlled bypass may be used to obtain warm air from the discharge air duct to reduce the pump room heating load during engine operation. Air obtained from bypass should be ducted to prevent it from recirculating directly back to the radiator.

Air-Cooled Engines. Air-cooled engines depend entirely upon ambient air to dissipate combustion heat. An engine-driven fan is used to insure positive movement of cooling air over the engine. Combustion and cooling air should be obtained from outside the pump room through free-swinging louvers having an effective net area of at least two times the area of the outlet from the engine cooling enclosure.

Cooling air from the engine should be ducted to outside the pump room through free-swinging louvers having an effective net area of at least one and one-half times the area of the engine enclosure outlet. Air-cooled engines require approximately the same amount of cooling air as comparably rated radiator-cooled engines.

A thermostatically controlled bypass may be used to obtain warm air from the discharge air duct to reduce the pump room heating load during engine operation. Air obtained from bypass should be ducted to prevent it from recirculating directly back to the engine cooling air intake.

8-3.2 Ventilation

For heat exchanger cooled Diesel Engine, each opening for intake and discharge ventilation in the pump room should be at least 0.75 in^2/Hp (6.5 cm^2/KW).

8-4.5* Fuel Supply Location

The engine fuel supply line should terminate above the ends of the fill and return lines. Fuel lines to the engine should be connected near the tank bottom and should be equipped with manual cock valve at the tank. This valve should be locked open or equipped with an automatic supervisory device. Metal-braided (or other substantially designed) flexible connectors should be used where fuel lines are attached to the engine.

8-5.3* Exhaust Piping

Automotive-type mufflers are not recommended because of their light construction and tendency to cause too much back pressure.

The pipe should be covered with high-temperature insulation up to 6 ft (1.8 m) above the floor or otherwise guarded to protect personnel from injury.

8-6.5* Temperature Maintenance

All engines should be equipped with jacket water heater capable of maintaining the temperature at 120°F (49°C).

Teflon hose with braided stainless steel jacket should be used on the outlet side of the water heater. This prevents premature hose failure caused by high heater outlet water temperatures.

Engines which are subjected to ambient temperatures less than 40°F (5°C) should be equipped with lubricating oil heater. When using such heater immersed in oil, the maximum surface temperature of the heater in contact with the oil should be less than 300°F (149°C). This will minimize the formation of hard carbon on the heating element. Shielded types of oil heaters generally meet this criterion. The engine manufacturer's recommendation for heaters to maintain 120°F (49°C) water and oil temperatures in ambient temperatures less than 40°F (4°C) should be followed.

Controllers of engines which are subject to ambient temperature conditions less than 70°F (21°C) during power failures should be equipped with power failure relay to start the unit upon loss of current output of the battery charger. Running the unit will maintain the oil and cooling water temperatures necessary for operation. Running the unit will also provide minimal flow through piping to help avoid freezeups. See FM Global Comment relating to NFPA 20 Section 9-4.2.

9-1 Application

Automatic Controllers. Automatic controllers are available for internal-combustion fire pump engines. The standards for construction, location, electric wiring, alarms, and methods of actuation are the same as for FM Approved electric controllers. All FM Approved automatic controllers are equipped with manual starting and stopping switches on the outside of the enclosure.

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Warning signals are provided to indicate failure to start, overheated engine (190°F [88°C] or over), low oil pressure, and overspeed of diesel engines. If overheating or low oil pressure occurs, the engine will continue to run until failure. If rated engine speed is exceeded by approximately 20%, the diesel engines stop. Contacts are provided to which pump running alarm circuits should be connected.

9-4.2 Alarm and Signal Devices Remote from the Controller

Power failure relays are not generally required on FM Global installations except as recommended in the FM Global comment for NFPA 20 Section 8-6.5 to maintain operation in cold temperatures during power failures.

9-5.2 Automatic Operation of the Controller

See FM Global comments for NFPA 20 Section 7-5.2 for starting and stopping recommendations.

9-5.2.4 Sequence Starting of Pumps

Sequential starting of engines is not recommended due to different length of time that engines crank.

9-5.2.7 Weekly Program Timer

Appropriate personnel should be in attendance for weekly pump running tests to monitor proper operation of the pump unit during the test, and to ensure that the unit is left in proper operating condition. This can best be done in conjunction with the weekly tests and inspections recommended in Chapter 11.

9-5.5 Methods of Stopping

Stopping should be manual.

Setting the run period timer to ‘‘Zero’’ is not an acceptable means of converting from automatic stop to manual stop. Approved methods for achieving this conversion are listed in the Factory Mutual *Approval Guide* for each controller equipped with run period timer.

Some controllers, when arranged for manual stop, and with the run period timer set at ‘‘Zero’’, are subject to cycling under the dictates of the pressure switch.

Run period timers should be checked regularly to insure they are set at not less than two to three minutes to prevent cycling.

9-6.7 Alarm and Signal Devices on the Controller

Power failure relays are not generally required on FM Global installations except as recommended in the FM Global comment for NFPA 20 Section 8-6.5 to maintain operation in cold temperatures during power failures.

9-6.10 Fire Protection Equipment Control

Battery power for initiating a signal for engine starting should be from batteries other than the engine starting batteries.

10-1.2 Turbines

Steam turbines of good quality and design and otherwise meeting the requirements of fire pump service are acceptable. Turbines designed to operate at less than 80 psi (552 kPa, 5.5 bar) are not acceptable. When normal operating boiler steam pressure is between 80 and 120 psi (552 and 827 kPa, 5.5 and 8.3 bar) the turbine should be capable of driving the pump at its rated speed and maximum pump load with a steam pressure as low as 80 psi (552 kPa, 5.5. bar) at the turbine throttle when exhausting against atmospheric back pressure, with the hand-controlled auxiliary nozzles open.

When normal operating boiler pressure is above 120 psi (827 kPa, 8.3 bar) the turbine should be capable of driving the pump at its rated speed and maximum pump load with steam pressure at the turbine as low as 70% of this normal pressure when exhausting against atmospheric back pressure and with the hand-controlled auxiliary nozzles open.

10-1.3 Steam-Supply Requirements

The steam supply should be sufficient to satisfy the maximum requirements given in the following table, which is based on an assumed 120 psi (827 kPa, 8.3 bar) steam pressure at the throttle, with atmospheric exhaust

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when running at rated speed and load, and with the hand-controlled auxiliary nozzles closed. For intermediate speeds not given in the table, the maximum steam consumption may be interpolated.

Steam Consumption. Steam consumption should not ordinarily exceed the values given in the table. Maximum steam-consumption rates are recommended in order to obtain turbines of good design that will not be likely to overtax the available steam supply.

10-2

Automatic steam-turbine drive should not be used on new installations, as there are no FM Approved drivers or controls.

11-2 Field Acceptance Tests

An FM Global representative should witness field tests before final acceptance of a pump installation. Sufficient time should be provided between notification and the test so that necessary information can be provided to the FM Global representative.

11-2.6.2.1

The reduced capacity should at least exceed the fire protection system water demand.

A flow meter should not be installed in a closed loop. With closed loop, if the suction supply valve were to be nearly shut the near-closure would not be detected. The flow meter should be tested for accuracy before the pump acceptance test to ensure that it is installed correctly.

Pump Performance Curves. In conducting a field acceptance test, the number and/or size of hose nozzles or the flow meter control valve should be varied. Thus, sufficient measurements will be obtained to plot at least five well-spaced points in order to check the net head characteristic curve of the pump. In field tests, actual speeds may vary from the rated speeds. Pumps operated at a constant speed less than rated speed would produce curves parallel to but below the one for rated speed. Curve B in Figure FM-A-11-2.6.2 is one produced by extreme variations from the rated pump speed. These conditions are unacceptable and should be corrected.

If pump speed varies at some points, the flows and pressures may be corrected to what they would have been at normal speed, provided the pump is operated within the design limits of its suction lift This can be done by use of the following relations.

1. The gpm is proportional to the velocity of the water and, therefore, to the velocity of the impeller (or rpm).

2. Net head is proportional to the square of the velocity of the water and, therefore, to the square of the rpm.

Occasionally a field acceptance test will indicate the advisability of change in impeller diameter. It is possible to determine approximately the effect on the head characteristic of cutting down the diameter of a given impeller. The velocity of the water is proportional to the diameter of the impeller at a constant rpm, and, therefore, gpm is proportional to the impeller diameter and net head to the impeller diameter square.

11-2.6.3.3

At any rate of pump discharge, the average value of the current in the three phases does not exceed 115% of the nameplate current for 40°C temperature-rise motors or for 1.15 service-factor motors. It does not exceed 100% of the nameplate current for 50°C or 55°C temperature-rise motors or for motors having service factor of 1.0. However, because of normal variations in the usual test equipment, observed readings may vary as much as 5% from true values. Therefore observed currents up to 120% may be accepted for 40°C or 1.15 service-factor motors, and up to 105% for 50°C, 55°C or 1.0 service-factor motors. Flow points should be chosen so that the current curve passes its maximum and levels off or drops. There should not be more than 10% differences in current between phases.

11-2.7.3

If the power failure relay is not needed in accordance with the FM Global Comment for NFPA 20 Section 8-6.5, it should be removed.

11-4 Periodic Inspection, Testing and Maintenance

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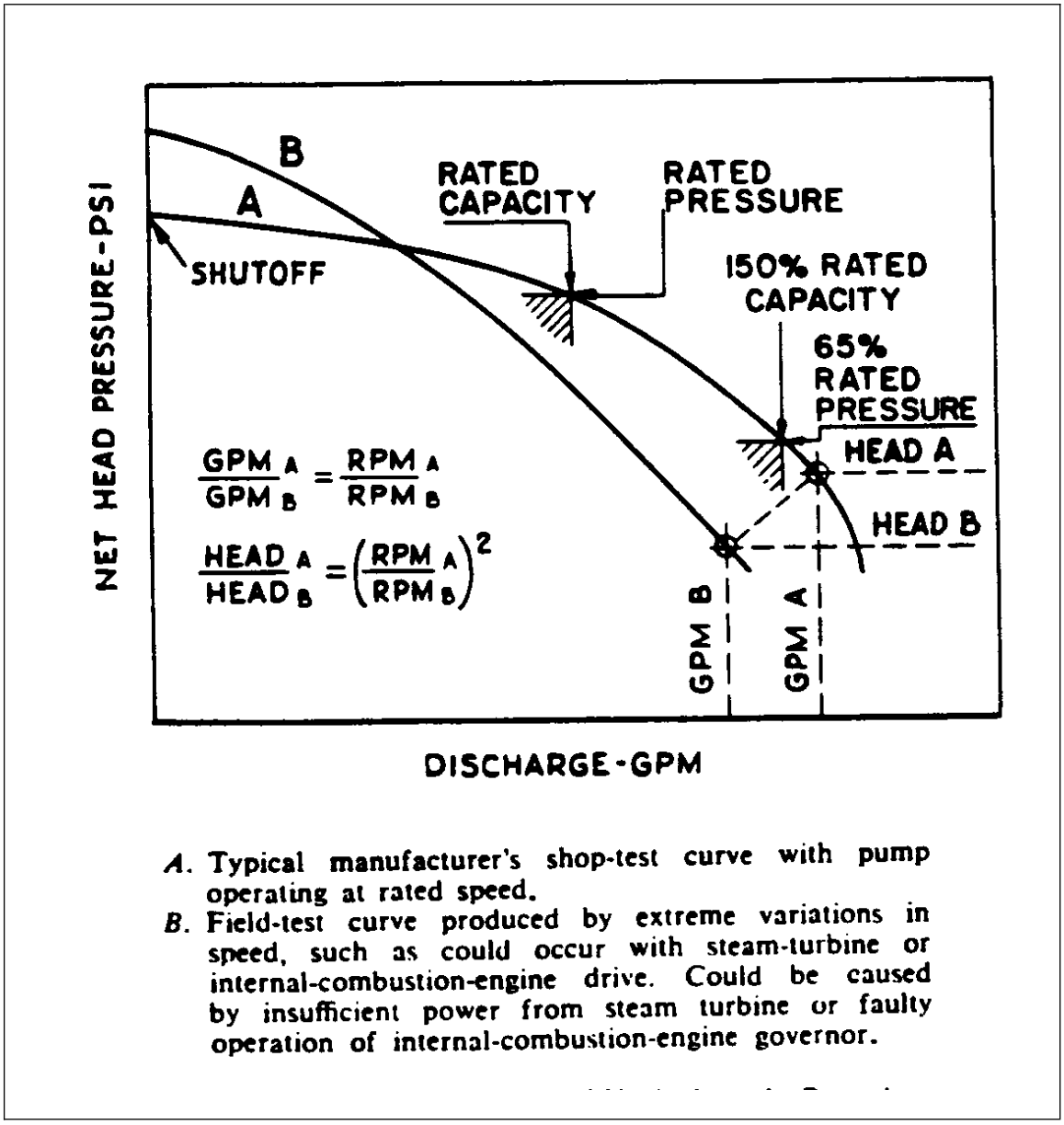

A. Typical manufacturer's shop-test curve with pump operating at rated speed.
B. Field-test curve produced by extreme variations in speed, such as could occur with steam-turbine or internal-combustion-engine drive. Could be caused by insufficient power from steam turbine or faulty operation of internal-combustion-engine governor.

Fig. FM-A-11-2.6.2 Effect of variations in speed on pump performance curve.

Piping with a hose header and a sufficient number of valves or piping with an FM Approved flow meter discharging to drain or to an impounded water supply are preferred. This allows check of the water supply from its source to the pump discharge.

Connecting the pump discharge through an FM Approved meter back to the pump suction is not recommended because of the possibility of creating hydraulic imbalance within the pump, and the inability to check the suction supply and piping upstream of the connection to the pump suction.

Piping should be large enough for at least 150% of rated pump capacity but not smaller than shown in Table 2-20.

Every fire pump engine (gasoline, gas, diesel) should be checked for overheating by running at least yearly with the pump discharging 150% or more of its rated capacity. Once the engine temperature has stabilized, the engine should be run for at least an additional 15 minutes.

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If the engine overheats, it is probably due to inadequate cooling water flow caused by an obstruction in the cooling water system.

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Recommended cooling water flow rates are as follows:

Engine Make and Model Number	*Speed r/min*	*Minimum Acceptable Heat Exchanger Flow Rate, gal/min (dm³/min)*
Caterpillar Tractor Co.		
3306 - PL2286, PL6819, PL6818	**All**	**50 (189)**
3306 - PL2285, PL6820, PL6821	**All**	**62 (261)**
3406 - PL2287, PL6822, PL6823	**All**	**50 (189)**
3406 - PL2288, PL6825	**1750**	**40 (151)**
3406 - PL2288, PL6824	**2100**	**50 (189)**
3408 - PL2289, PL6827, PL2313 PL6829	**1750**	**70 (265)**
3408 - PL2289, PL6826	**2100**	**60 (227)**
3408 - PL2313, PL6828	**2100**	**75 (284)**
3412 - PL2414, PL6831, PL6830 PL2415, PL6833, PL6832	**All**	**100 (379)**
Clark GM Diesel		
DDFP - 03AN	**1470** **All others**	**14.5 (55)** **22.5 (85)**
DDFP - 04AN	**2300** **All others**	**20.5 (78)** **19 (72)**
DDFP - 04AT	**1470** **1750** **All others**	**17.5 (66)** **50 (189)** **55 (208)**
DDFP - 06AT	**2100** **2300** **All others**	**53 (201)** **53 (201)** **62 (235)**
Cummins Engine Co.		
VT-1710-F	**All**	**65 (246)**
All other models	**All**	**34**
Dorman Diesels Ltd.		
8J and 8JT	**1750**	**87 (329)**
	1800	**90 (341)**
	2000	**98 (371)**
	2100	**102 (386)**
	2200	**104 (394)**
Flowmetrico Ltd.		
M 685 NA	**All**	**14 (53)**
GEC Diesels, Inc. (formerly Ruston)		
4LDF	**All**	**13 (49)**
4LDTF	**All**	**10 (38)**
6LEF	**1800**	**14 (53)**
6LDTF	**All**	**17 (64)**
6LDTCWF	**1800**	**19 (72)**
6QTCWF	**All**	**27 (102)**
6LET	**All**	**29 (110)**
6LETCW	**All**	**32 (121)**
Kirloskar Cummins Ltd.		
V-1710-F, VT-1710-F and VTA-1710-F	**All**	**65 (246)**
other models	**All**	**32 (129)**
Lindenburg Aggregate Gmbh.		
OM 402	**1500**	**7 (26)**
OM 402	**1800**	**8 (30)**
OM 402	**2300**	**9.5 (36)**
OM 403	**1500**	**9.5 (36)**
OM 403	**1800**	**11 (42)**
OM 403	**2300**	**14 (53)**
OM 404	**1500**	**17.5 (66)**
OM 404	**1800**	**21 (79)**
OM 404	**2300**	**27 (102)**

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Engine Make and Model Number	*Speed r/min*	*Minimum Acceptable Heat Exchanger Flow Rate, gal/min (dm³/min)*
Mortoren-Werke		
D232-V6	**All**	**10 (38)**
D232-V8	**All**	**20 (76)**
D232-V12	**All**	**18 (68)**
Stewart & Stevenson Services, Inc.		
FFH-852T-1,2	**All**	**39 (148)**
FFV-852T-1	**1800**	**100 (379)**
FFV-852T-2	**2100**	**113 (427)**
FFV-852T-2	**2300**	**133 (503)**
FFH-1136T-1,2	**All**	**108 (409)**
FFV-1136T-1,2	**All**	**133 (503)**
FFH-1704T-1,2	**All**	**331 (1253)**
FFV-1704T-1,2	**All**	**317 (1200)**
Waukesha Engine Division		
F476DSUF	**1760**	**14 (53)**
F476DSUF	**2100**	**15 (57)**
F674DSUF	**1760**	**15 (57)**
F674DSUF	**2100**	**17 (64)**
F674DSIUF	**1760**	**16 (61)**
F674DSIUF	**2100**	**18 (68)**
H866DSIUF	**1800**	**38 (144)**
H866DSIUF	**2100**	**40 (151)**
H867DSIUF	**All**	**50 (189)**

Minimum pressure and maximum pressure can be obtained from the local engine distributor. The rate at which water is discharged from the heat exchanger and exhaust manifold should be checked. Compare the cooling water discharge rate with previous observations and/or the recommended rate. Usually 5 gal (18.9 dm^3) container and a watch with a second hand are all the equipment that is required for the cooling water flow check.

All engine overheating problems should be corrected immediately. There are several corrective measures that can be taken to increase cooling water flow rates and to reduce overheating.

1. Check and clean, as necessary, the in-line strainer (if installed).

2. Check the valves (solenoid and manual) in the cooling water piping (valve on each side of the pressure-reducing regulator should be open; valves on the bypass should be closed).

3. Increase the water flow through the heat exchanger by adjusting the pressure-reducing regulator.

4. Open the bypass valve.

5. Replace the heat exchanger and/or water-cooled exhaust manifold.

6. Check any thermostat in the engine cooling water system for proper operation.

CAUTION: If it is necessary to open the bypass valve, in addition to adjusting the pressure regulator, to obtain an adequate cooling water flow rate, do not exceed the maximum recommended pressure for the particular heat exchanger. The maximum recommended pressure could be as low as 50 to 60 psi (345 to 413 kPa, 3.45 to 4.13 bar). If the engine overheats, a copy of the report noting the manufacturer, serial number and condition of the engine and the remedy(s) taken should be sent to FM Global.

The chart Figure FM-11-4 is intended to aid in checking tests of centrifugal fire pumps. It provides a means of obtaining a consistent rating.

A pump is an important unit of the fire protection system and as such should be properly maintained. If a pump test indicates a ‘‘poor’’ rating or there is more than a minor change between tests in the ‘‘good’’ rating range, the cause should be ascertained and the condition remedied without delay.

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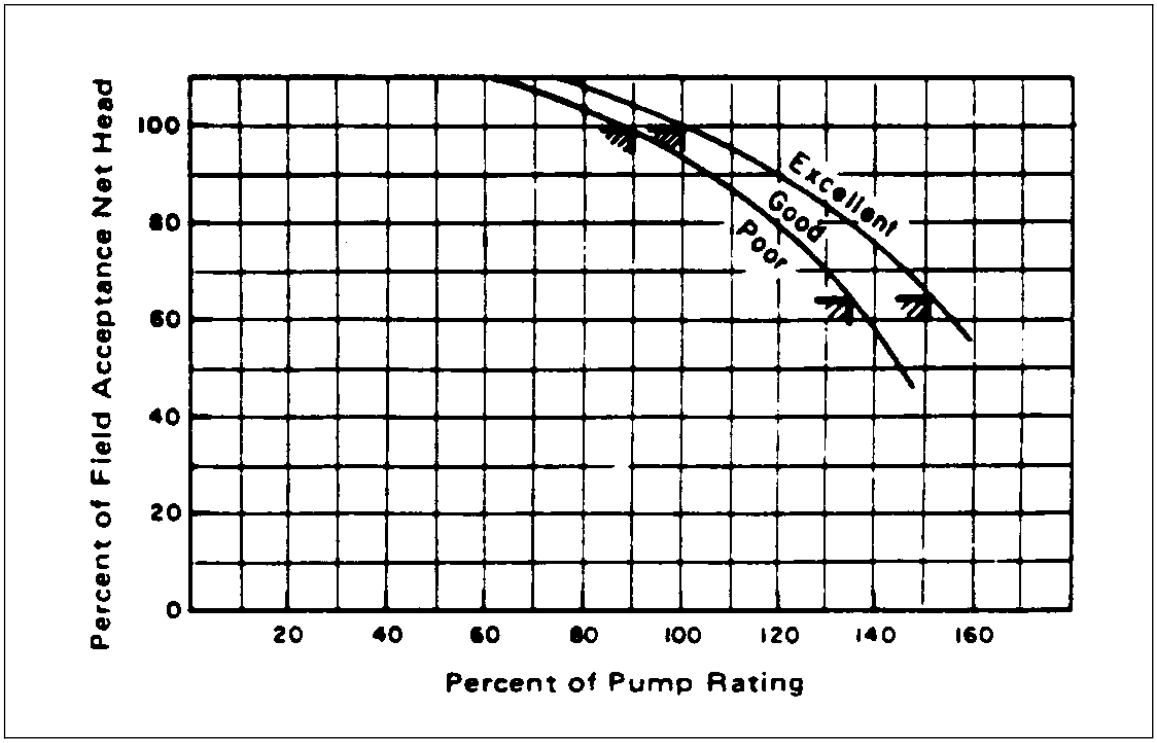

Fig. FM-11.4 Rating chart for centrifugal fire pumps.

Capacity Tests. The condition of each pump should be determined at least annually by an operating test. At least three well-spaced pressure and flow points (shut-off or churn, near rating and at or near 150% of rating, except as noted in NFPA 20 Section A-2-1.2) should be compared with the Field Acceptance Test is available, not the theoretical or manufacturer's curve. In the event water disposal is a problem obtain the shut-off pressure and a point near 150% of rated capacity. It is a FM Global practice to have representative witness such capacity tests. The test is made by discharging water through an FM Approved flow meter or by discharging water through hose(s) attached to yard hydrant(s) or directly to a hose header. The rate at which water is discharged by the pump may be read directly from the FM Approved flow meter. Many points can be obtained quickly with minimum water discharge when a flow meter is available for testing. The rate at which water is discharged from a hose nozzle is measured by comparing readings taken with a pitot tube and pressure gage and those in the FM Global Nozzle Discharge Table.

Pump performance should be compared with the Field Acceptance Test (see NFPA 20 Section 11-2) and any previous test. A reduction in capacity of up to 10% over the life of the pump due to normal wear is tolerable.

Normally there is no more than a slightly noticeable difference, if any, between tests.

More than a slightly noticeable reduction in capacity may be due to one or more of number of causes as shown in Appendix B; plugged impeller and obstructed suction are among the more common. In some cases, the reading of the suction gage will indicate whether the trouble is due to a plugged suction.

If there is more than a slightly noticeable reduction in capacity or the flow will not meet the required demand, the cause should be ascertained and the condition remedied without delay.

Pumps should stop manually.

Where a fire pump is installed, someone adequately instructed in its operation should be present at all times when the pump is running.

A fire pump is valuable only if put into use at the right time. It is important that the essentials of operation be understood by the plant personnel.

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Make certain that the plant watch person or other qualified persons are adequately instructed in fire pump operation. They may be required to operate the pump when there is no one else at the plant. Monthly review of the watchman's ability to operate the pump is recommended.

Operating instructions should be posted in the pump room. These should include manufacturer's operating instructions regarding the controls and pump and indication of what valves should be open. They should also include methods of getting assistance in an emergency.

Where the suction supply is from public service mains, the test should not draw the residual pressure at the pump below 20 psi (138 kPa, 1.38 bar).

Inspection and Test. To make sure that the pump installation is always ready for service, the pump should be started weekly and run at full speed, discharging through a convenient outlet. Electric-motor driven pumps should run for a minimum of 10 minutes; diesel-engine driven pumps should be run for a minimum of 30 minutes.

Automatic starting should be tested by dropping system pressure or, where flow is controlled, by drawing water from the yard or sprinkler system.

At each test, checks should be made of the operation of the priming devices, the temperature and tightness of the glands, the readings of the suction and discharge gages, and the condition of the suction supply. Check actual start and stop pressures against pressure switch settings every time the fire pump unit is started.

With electric-motor drive, operation of the starting devices should be checked. With steam-turbine drive, make sure that the steam trap for removing condensed steam at the throttle is working properly; observe the steam pressure with the pump delivering water; and the test the operation of the speed and pressure governors, the overspeed trip, and the steam and water relief valves.

With internal-combustion-engine drive, make sure that the engine is clean and dry. Check the fuel tank and keep it at least three-fourths full. Check the quality and quantity of the crankcase oil, and change when it has become fouled or has lost viscosity. Make sure that the battery charger is operating properly. Run the engine at rated speed with the pump discharging water for preferably 30 min but not less than 20 min Check and clean the strainer in the cooling-water system. Test the operation of the speed governor and water relief valve.

Check and clean the strainer in the cooling-water system. Test the operation of the speed governor and water relief valve.

Check the specific gravity of the battery electrolyte at least monthly.

Check the oil filter annually, regardless of engine operation.

Change any cooling fluids per engine manufacturers guidelines and/or inspections.

If tests show need of repairs or adjustments, they should be made as soon as possible, following manufacturer's instructions very carefully.

This should include replacement of belts, oil, filters, etc. as recommended.

STRICTLY ADHERE TO THE ENGINE MANUFACTURERS SPECIFICATIONS FOR ALL FLUIDS AND PARTS USED.

A stock of spare parts should be kept in the pump room.

2.3 Fire Pumps for High-Rise Buildings

2.3.1 General

Fire pumps may be used for automatic sprinkler systems, standpipe and hose systems, and combined systems (automatic sprinkler systems having standpipe-type hose outlets for fire department use). For guidelines for each of these systems refer to Data Sheet 2-8N, *Installation of Sprinkler Systems*, and Data Sheet 4-4N, *Standpipe and Hose Systems*. Compliance with all other chapters of this standard except as otherwise specified herein should be followed.

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Requirements for sprinkler systems sometimes necessitate complete separation from the standpipe system. Common protection may be possible, provided that requirements for both sprinkler and standpipe protection are met in accordance with Data Sheet 2-8N, *Installation of Sprinkler Systems*, and Data Sheet 4-4N, *Standpipe and Hose Systems*.

2.3.2 Pump Arrangement

Vertical series staging of fire pumps should not be accepted for direct pumping to sprinkler systems, because of both reliability concerns and the fact that there are no FM Approved controllers for series staging of fire pumps.

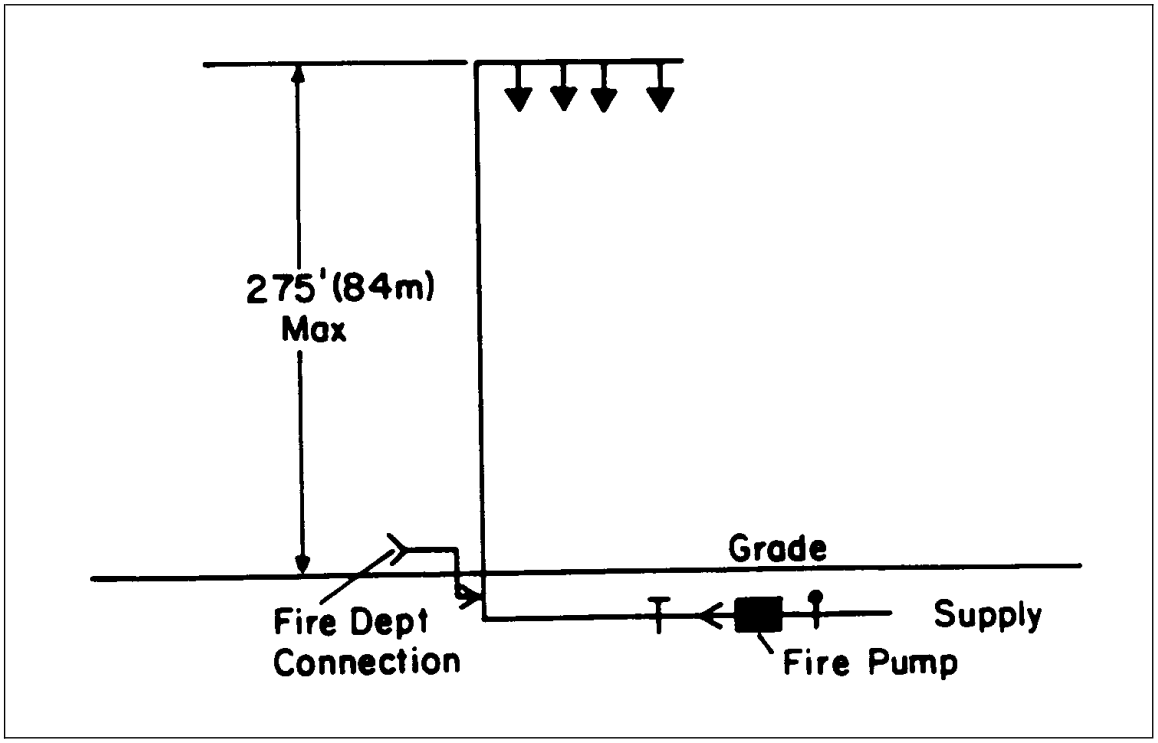

Fig. FM-2-3(a). Single-zone pumped system.

In series staging, the first (lowest) pump discharges to the first zone sprinklers and the suction of the second pump; the second pump discharges to the second zone sprinklers and the suction of the third pump; etc. If fire occurred near the top of building having three vertical zones, it would be necessary for the first pump to start, then the second, then the third. Any one of the three pumps failing to start would prevent water from being supplied to the upper floor sprinklers.

Proposals for vertical series staging of fire pumps are increasing. These proposals are being offered as alternatives to the accepted practice of storing water or direct pumping to meet sprinkler demands. With an approximately 3% failure-to-start rate for electric-motor driven units, the reliability for the third zone is reduced from 97 to 91%. Almost one in eleven times, there is no water available in the third zone. (The failure-to-start rate was obtained from 1976 Factory Mutual Research Survey of fire pump reliability.)

Fire protection systems in high rise buildings should be vertically zoned every 275 ft (84 m) or so. When the public water supply cannot meet the pressure requirements of the sprinkler system in building 275 ft (84 m) or less above grade, the sprinklers may be supplied by booster pump taking suction from the public main [Figure FM-2-3(a)]. Sprinklers may also be supplied by gravity tank of sufficient capacity above the roof [Figure FM-2-3(b)]. The tank filling pump should be capable of refilling the tank within 8 hours. Where two water supplies are required, either or both may be pump or tank [Figure FM-2-3(c)].

Buildings in excess of 275 ft (84 m) above grade should be divided into two or more zones of 275 ft (84 m) or less. Each zone should have its own water supply and independent fire department connections.

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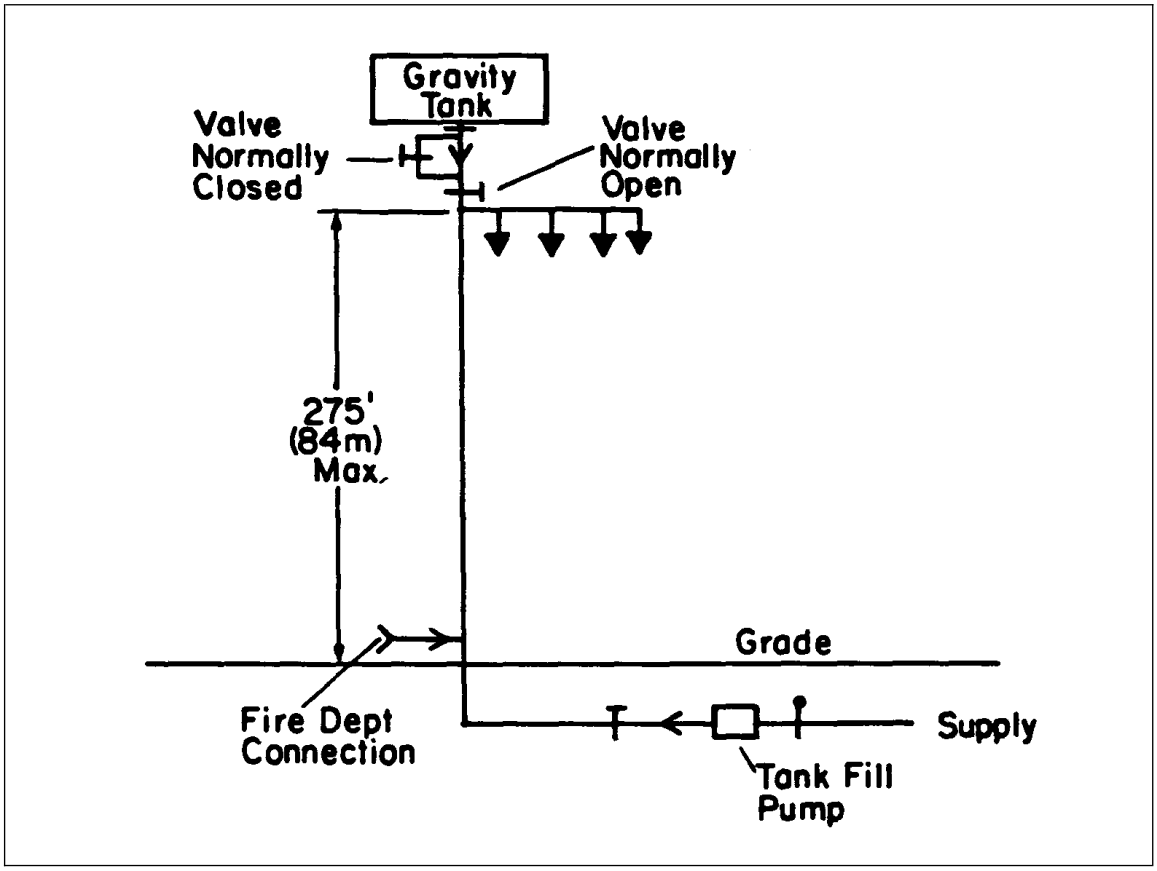

Fig. FM-2.3(b). Single-zone gravity system.

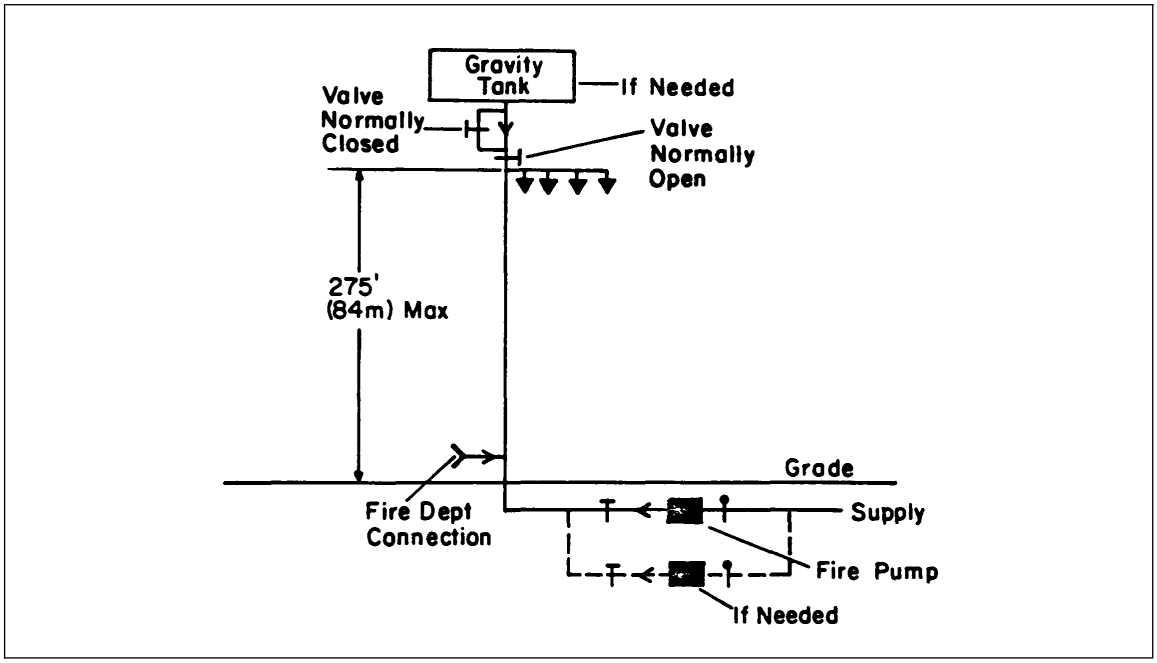

Fig. FM-2-3(c). Single-zone system, two supplies.

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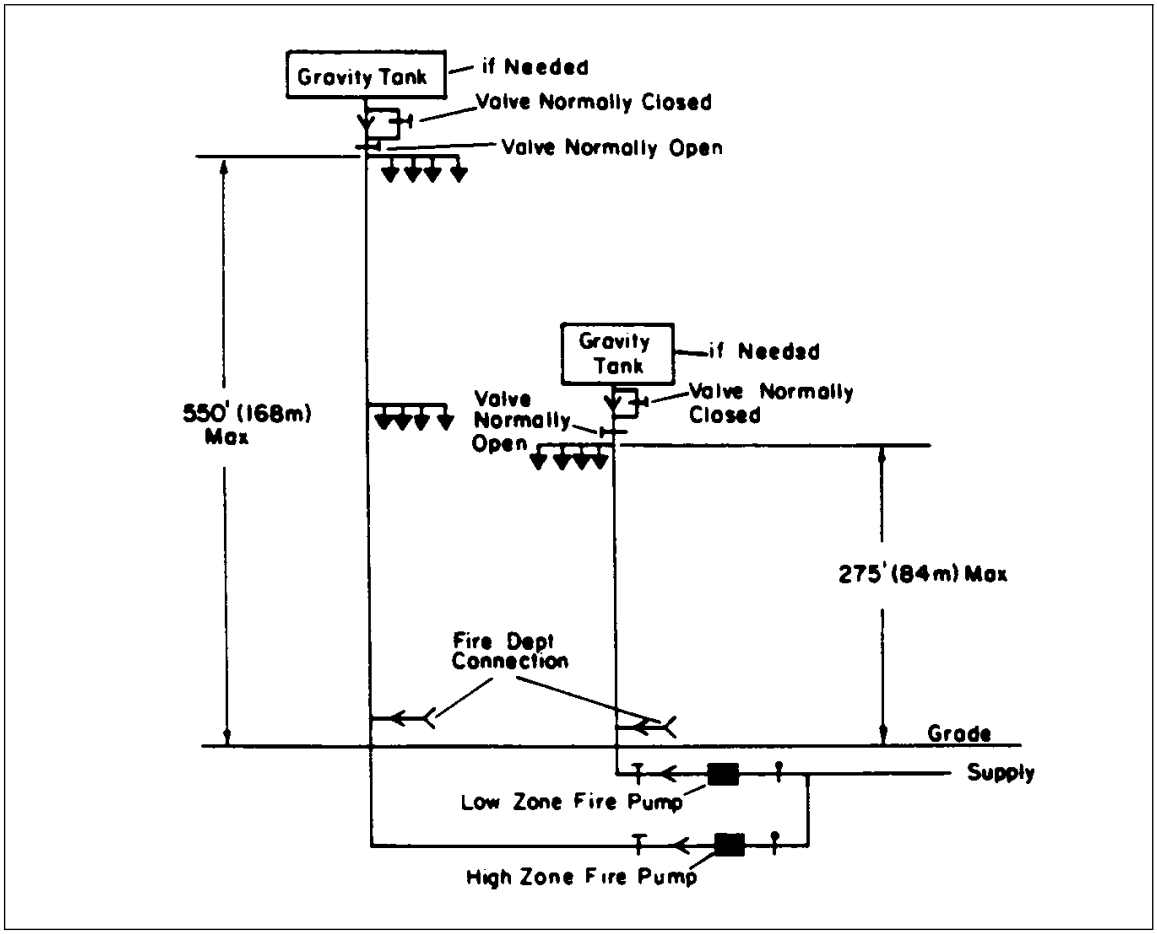

Fig. FM-2.3(d). Two-zone system.

Figure FM-2-3(d) illustrates a two-zone system for building having maximum height of 550 ft (168 m). This system includes minimum of two fire pumps, each connected to the public water supply. If two water supplies are necessary, each zone would have the second pump in parallel or a gravity tank at the top. The gravity tank may be refilled by the fire pump for that zone or a separate tank filling pump.

Figure FM-2-3(e) illustrates an alternate, two-zone system. The low zone fire pump is located on the lower service floor and connected to the public water supply. The second fire pump, serving the high level zone, is located at the 275 ft (84 m) level and obtains water from a tank at the same level. The tank is filled from either the low level zone fire pump or a separate tank filling pump.

Buildings having three or more zones of 275 ft (84 m) each should duplicate the high zone arrangement from Figure FM-2-3(d) or Figure FM-2-3(e) for the third and higher zones. Pump suction tanks should be able to supply the required demand for the expected duration without makeup.

Gravity tanks should, at a minimum, be able to supply the sprinkler demands for the expected duration.

2.3.3 Driver

Diesel engines or electric motors are acceptable for driving fire pumps in high-rise buildings.

2.3.4 Power Supply

Power for driving fire pumps in high-rise buildings shall be selected on the basis of adequacy, reliability, and safety.

Where electric motors are used and the height of the structure is beyond the pumping capability of the fire department apparatus, a reliable emergency source of power shall be provided for the fire pump installation.

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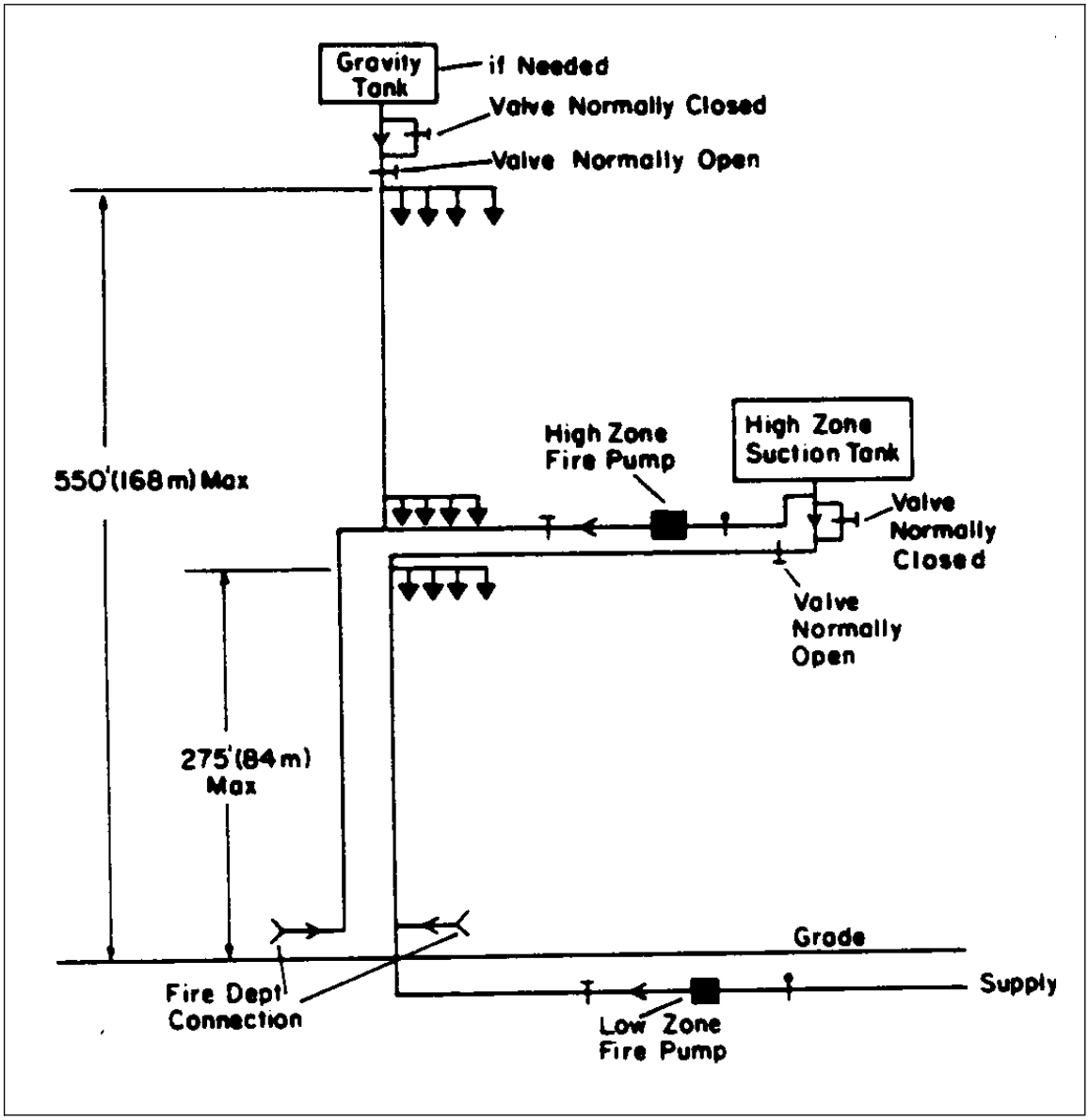

Fig. FM-2.3(e). Two-zone system.

This emergency source of power may be provided either by dedicated standby engine-driven generators or by emergency power sources for services essential to the safety and welfare of high-rise building occupants. In the latter case, the capacity of the emergency power source should be capable of supplying the total demand, including that for the fire pump.

2.4 (FM) FM Global Equipment Alerts

2.4.1 Diesel Engine Drivers

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2.4.1.1 Clarke GM Diesel Models MD-3, MD-4, MD-6, and MD-6T: MD Fire Pump Campaign (first published October 1989).

RECOMMENDATION

When a Clarke diesel engine Model MD-3, MD-4, MD-6 and MD-6T is located, determine if its date of manufacture is between April 1986 and December 1988. If the engine was manufactured between these dates, determine if the governor spring has been replaced with a blue-stripped spring supplied by Clarke GM Diesel.

If the governor spring has not been replaced, contact Paul Canter at (513) 771-2000, Extension 339, for a replacement spring.

DISCUSSION

All Model MD-3, MD-4, MD-6 and MD-6T engines manufactured between April 1986 and December 1988 have not been located by Clarke. Because of the serious results from the spring breaking, Clarke has asked for assistance in locating the suspect engines.

The bottom line on the identification plate contains the month and year of manufacture.

If the governor spring breaks, the fail-safe design of the Clarke System permits the engine to start and run by command from the controller. If the spring breaks, the STOP signal would be ignored, but the raw water solenoid would close, causing the engine to overheat and fail.

Additional information and instructions from the manufacturer follow in Figures 2.4.1.1.1 through 2.4.1.1.6.

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3133 EAST KEMPER ROAD
CINCINNATI, OH 45241
513/771-2200

1340 TERMINAL ROAD
INDIANAPOLIS, IN 46217
317/783-6651

2610 INDEPENDENCE DRIVE
FORT WAYNE, IN 46808
219/482-9185

2697 GRASSLAND DRIVE
LOUISVILLE, KY 40299
502/491-2021

CLARKE
GM DIESEL

May 11, 1989

Name
Address
City, State, Zip

Subj: Mandatory Governor Spring Replacement
Diesel Fire Pump Driver

Reference: Model:
S/N:

Sir/Madam:

The referenced unit has been identified as being under your care and custody. It has come to our attention that the engine governor spring on your unit might contain a manufacturing defect which could cause the spring to break. If that occurs, the failsafe design of the Clarke system would permit the engine to start and run by command from the CONTROLLER. However, upon signal to STOP the unit would continue running. Since the STOP signal also effects the closing of the raw water solenoid valve, the unit would fail due to overheating. Should such break occur, major expense and considerable lost time would be involved to repair the engine. Furthermore, the facility served by the pump would be without the safety protection provided by the pump during the service interval.

A campaign has been initiated to replace the spring on your unit. IT IS MANDATORY THAT YOU CHANGE THIS SPRING. The enclosed replacement spring has a blue strip for ease of identification. You should make arrangement to have this spring installed immediately. Detailed instructions are enclosed, and the job can be completed in less than a minute without special tools or training. Insurance agencies have been notified of this situation and their field inspectors will be looking for the presence of the replacement spring.

If you have any questions regarding this situation or the instructions provided, please call me at A/C 513-771-2200 X307. Collect calls will be accepted if you identify your call as relating to a "MD Fire Pump Campaign".

Thank you.

Very truly yours,

Dane Petrie
Manager - Sales Operations
Fire Pump Products

/bjh

Enclosure

1. Installation Instructions
2. Spring - Blue Stripped

Fig. 2.4.1.1.1 Clarke notification.

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2697 GRASSLAND DRIVE
LOUISVILLE, KY 40299
502/491-2021

CLARKE
GM DIESEL

May 12, 1989

Armand Brando
Factory Mutual Research
1151 Boston-Providence Highway
P.O. Box 9102
Norwood MA 02062

Subj: Mandatory Governor Spring Replacement
Diesel Fire Pump Driver

Reference: Clarke Models MD-3, MD-4, MD-6 and MD-6T
Production Dates: April '86 thru Dec. '88

Sir/Madam:

The referenced Clarke models produced during the dates shown might contain a manufacturing defect. That defect could cause the spring to break. If that occurs, the failsafe design of the Clarke system would permit the engine to start and run by command from the CONTROLLER. However, upon signal to STOP, the unit would continue running. Since the STOP signal also effects the closing of the raw water solenoid valve, the unit would fail due to overheating.

At this point, major expense and considerable lost time is involved to repair the engine. The facility could be without this safety protection during that service interval.

A campaign has been initiated to replace the spring on all units referenced above. Letters will be sent to all known owners and Original Equipment Manufacturers. A copy of the letter and instructions to be sent are enclosed for your review. Included in that mailing will be replacement spring.

Because Clarke does not know all of the unit locations, I ask that your company assist Clarke in the identification process. Please have your field representatives contact Paul Canter at A/C 513-771-2200 X339 or FAX the information to his attention at A/C 513-771-0520. Clarke will accept collect calls regarding this issue if the caller identifies the call as relating to the "MD Fire Pump Campaign".

I thank you for your support and assistance regarding this matter.

Very truly yours,

John Whitney
Engineering Manager

/sr
Enclosure

Fig. 2.4.1.1.2 Clarke notification to Factory Mutual Research.

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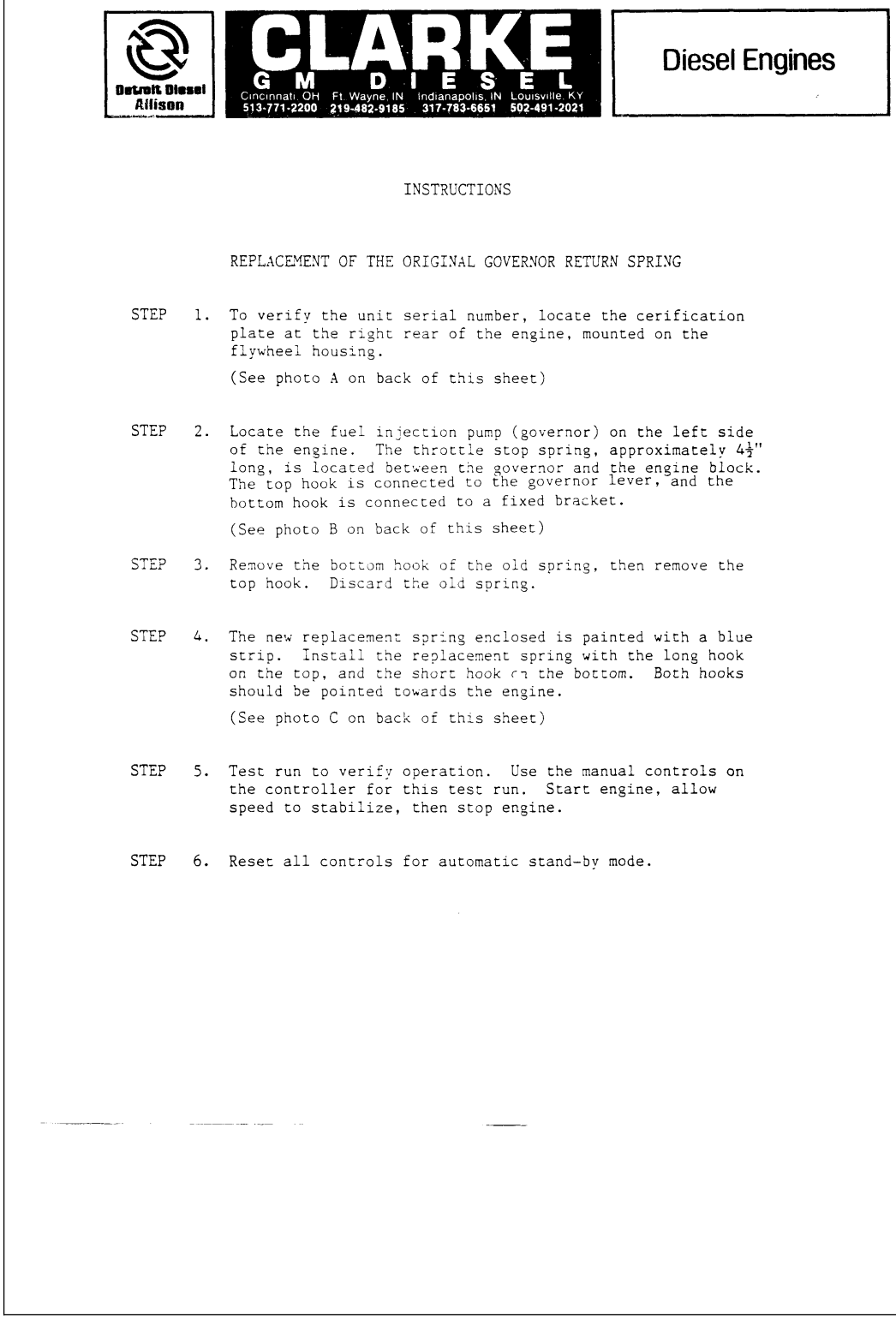

Detroit Diesel Allison

CLARKE
G M D I E S E L
Cincinnati, OH 513-771-2200 | Ft. Wayne, IN 219-482-9185 | Indianapolis, IN 317-783-6651 | Louisville, KY 502-491-2021

Diesel Engines

INSTRUCTIONS

REPLACEMENT OF THE ORIGINAL GOVERNOR RETURN SPRING

STEP 1. To verify the unit serial number, locate the cerification plate at the right rear of the engine, mounted on the flywheel housing.

(See photo A on back of this sheet)

STEP 2. Locate the fuel injection pump (governor) on the left side of the engine. The throttle stop spring, approximately 4½" long, is located between the governor and the engine block. The top hook is connected to the governor lever, and the bottom hook is connected to a fixed bracket.

(See photo B on back of this sheet)

STEP 3. Remove the bottom hook of the old spring, then remove the top hook. Discard the old spring.

STEP 4. The new replacement spring enclosed is painted with a blue strip. Install the replacement spring with the long hook on the top, and the short hook on the bottom. Both hooks should be pointed towards the engine.

(See photo C on back of this sheet)

STEP 5. Test run to verify operation. Use the manual controls on the controller for this test run. Start engine, allow speed to stabilize, then stop engine.

STEP 6. Reset all controls for automatic stand-by mode.

Fig. 2.4.1.1.3 Clarke instructions for governor spring replacement.

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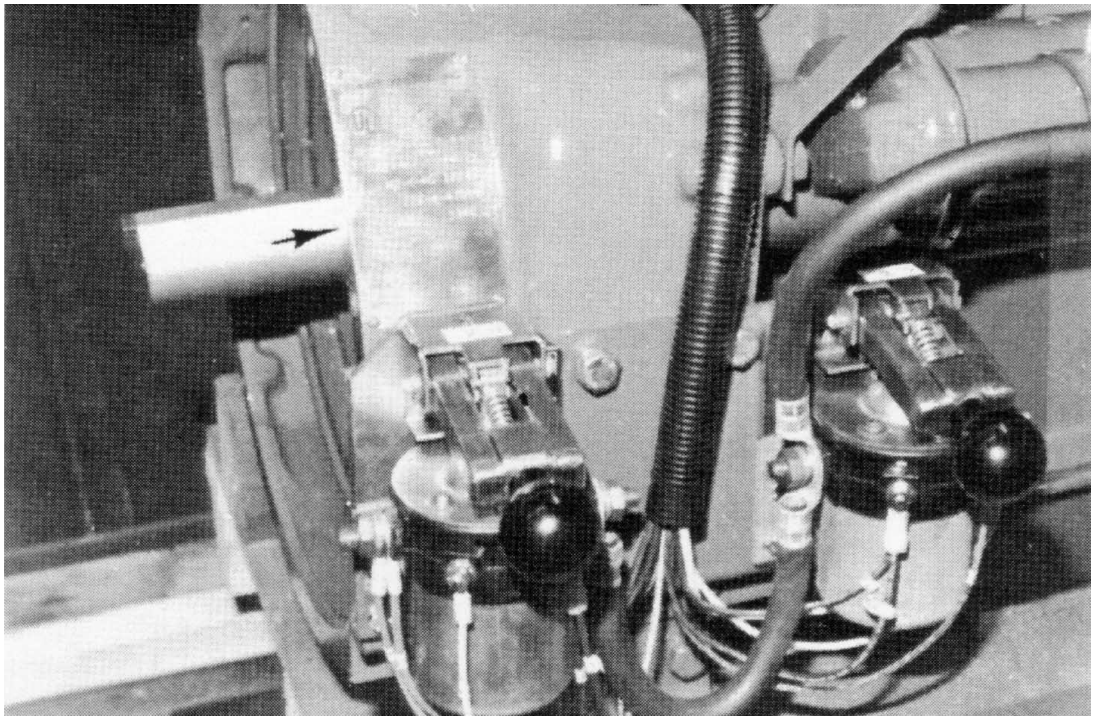

Fig. 2.4.1.1.4 Photo A.

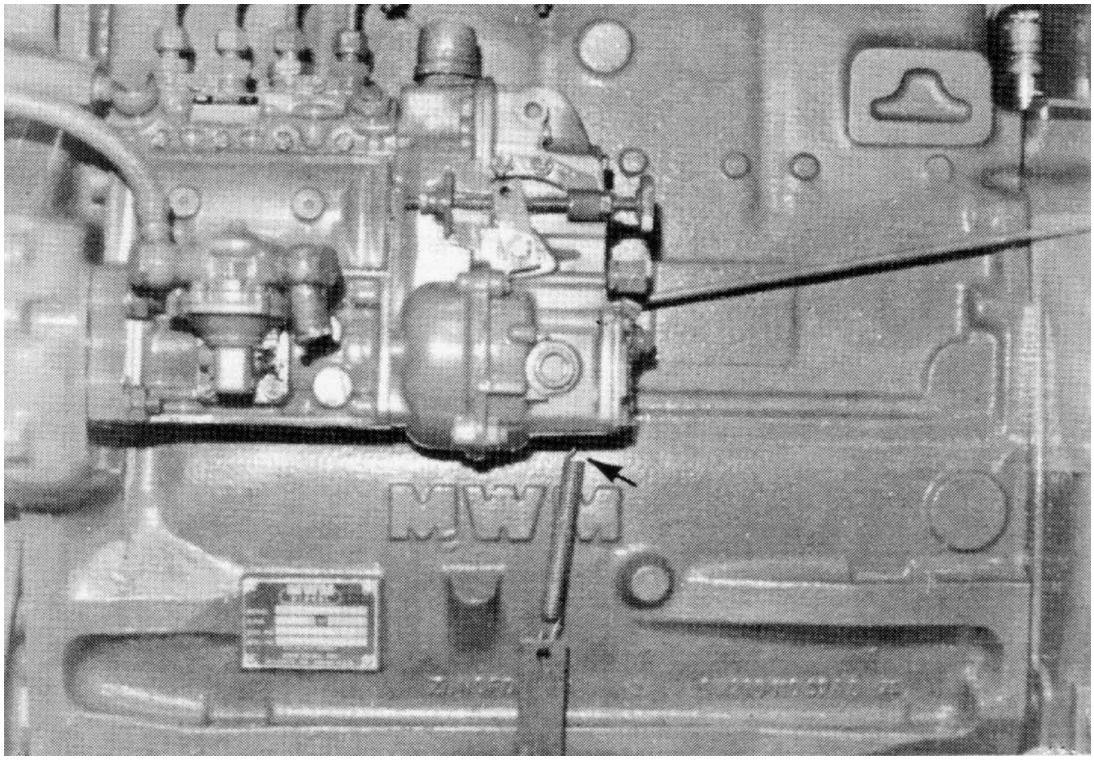

Fig. 2.4.1.1.5 Photo B.

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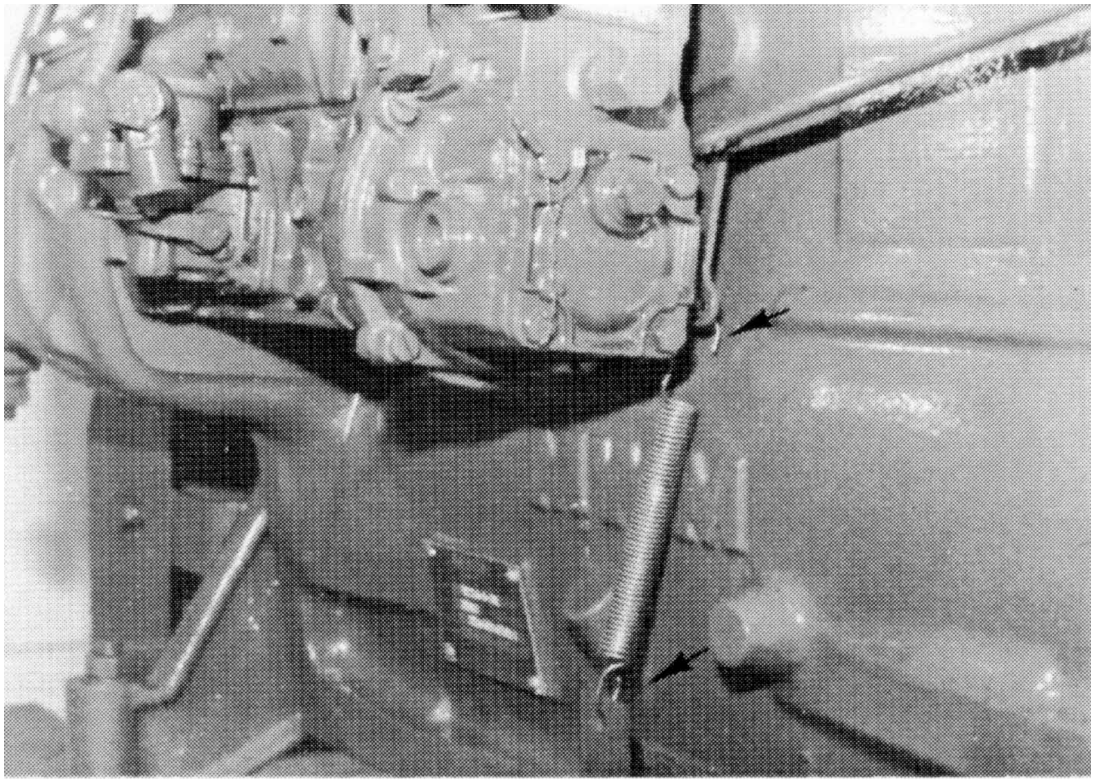

Fig. 2.4.1.1.6 Photo C.

2.4.1.2 Cummins Engine Company Models V-378 and V-504 Fire Pump Engines Return Fuel Plumbing; Cummins Campaign No. 8422 (first published April 1985).

RECOMMENDATION

All Cummins Model V-378 or V-504 engines, having a serial number lower than 220235057 must have fuel piping systems installed or modified in accordance with Cummins Campaign No. 8422. No other method should be accepted. If you have an engine as described above that has not had the return fuel plumbing modified, contact your local Cummins Engine Co. distributor.

DISCUSSION

An engine with a serial number lower than 20235057 is subject to hydraulic lock in the event of a check valve leak or failure during a shutdown period. A hydraulic lock (fuel draining into a cylinder) can prevent the engine from starting.

The expiration date of Cummins Campaign No. 8422 was extended in 1986 in an added effort to locate all Model V-378 and V-504 engines with a serial number lower than 20235057 driving fire pumps. The Cummins distributor should refer to Campaign 8422, 8422A, 8422B, and 8422C.

It is possible that some V-378 and V-504 engines that were not shipped as fire pump drivers have been converted in the field without Cummins' knowledge.

The following information in Figures 2.4.1.2.1 through 2.4.1.2.6 represents Cummins Campaign No. 8422 literature.

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Cummins Engine Company, Inc.
Box 3005
Columbus, Indiana
47202-3005

Mr. Thomas J. Brown
FACTORY MUTUAL RESEARCH CORPORATION
1151 Boston - Providence Turnpike
Norwood, MA 02062

Dear Mr. Brown:

Subject: Separate Fuel Line to Fuel Source on V-378 and V-504 Fire Pump Engines Campaign 8422

This is in response to our phone conversation on the above subject. We have no objection to Factory Mutual publishing Campaign Letter 8422 and all the attachments to send to anyone they deemed necessary to aid in carrying out the completion of this campaign.

We appreciate your assistance in this matter.

Very truly yours,

Rose Hoover

RMHoover/djm

Certification Engineer

cc: A. Brandao - FM

Fig. 2.4.1.2.1 Cummins letter.

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CUMMINS ENGINE COMPANY
BOX 3005
COLUMBUS, IN. 47202-3005

M/C80312
WORLDWIDE CLMS MGT.

8422

** CAMPAIGN **

AUGUST 31, 1984

SUBJECT: V-378 AND V-504 FIRE PUMP RETURN PLUMBING

CAMPAIGN NO.	EXPIRATION DATE	CONTACT
8422	AUGUST 31, 1985 (US/CAN) NOVEMBER 30, 1985 (INTL)	CAROLYN HIOTT/(812)377-8152

DESCRIPTION ALL FIRE PUMP ENGINES HAVE OVERHEAD FUEL TANKS BY AGENCY REQUIREMENT. IN THE UNLIKELY EVENT OF A CHECK VALVE FAILURE, HYDRAULIC LOCK OF THE ENGINE MAY OCCUR DURING A SHUTDOWN PERIOD WHICH COULD PREVENT THE ENGINE FROM STARTING IN AN EMERGENCY SITUATION.

ACTION A FUEL RETURN LINE FROM THE PTR FUEL PUMP TO THE TOP OF THE FUEL SUPPLY TANK MUST BE INSTALLED SEPARATE FROM THE INJECTOR RETURN LINE. ENGINE NOT YET INSTALLED WILL ONLY REQUIRE THE FUEL CONNECTIONS ON THE ENGINE TO BE MODIFIED. SEE THE ATTACHED FOR INSTRUCTIONS AND THE ENGINE SERIAL NUMBERS.

PAGE TWO OF THE CLAIM FORM MUST BE FILLED OUT BEFORE REIMBURSEMENT WILL BE MADE.

MATERIAL DISPOSITION SCRAP

REIMBURSEMENT - IN OR OUT OF THE BASE WARRANTY PERIOD

LABOR--- ACTUAL TIME, BUT NOT TO EXCEED 2.0 HOURS.
PARTS--- AT DISTRIBUTOR OR DEALER NET, PLUS MARK-UP AND BFC WHERE APPLICABLE.
TRAVEL ACCORDING THE BASE WARRANTY GUIDELINES

CLAIM INSTRUCTIONS
PAY CODE(1,2,3).....X(DIST)
PAY CODE(1,2,3).....D(DLR.)
PAY CODE(1,2,3).....I(INTL)
ACCOUNT CODE(1,2,4).....65
AUTHORIZATION(1,2,5).....8422
SEVERITY CODE(3,2,2).....A
FAILURE CODE(3,2,3).....W F L F S C

DISTRIBUTED TO: US AND CAN. DISTRIBUTORS AND BRANCHES
INTERNATIONAL DISTRIBUTORS AND BRANCHES
DIVISIONAL OFFICES
INTERNATIONAL REGIONAL OFFICES

3

Fig. 2.4.1.2.2 Cummins campaign 8422 description.

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Attachment I
Campaign 8422

NOTE:

Prior to going to the job site, contact the appropriate personnel to determine the approximate distance between the engine and fuel supply tank. Also, determine the available fuel return openings in the top of the fuel tank and pipe fitting sizes that may be required.

The following parts will be necessary:

1. ⅜ inch O.D. soft copper tubing — length determined by individual installation.
2. (1) ⅜ inch diameter by 18 inch length flexible metal fuel line connection.
3. (1) ¼ inch NPTF pipe plug.
4. (1) S-1040-A adapter elbow
5. Pipe connections to secure flexible metal connection and copper tubing between the fuel pump drain elbow (⅝-18 male thread) and the top of the fuel tank.
6. Pipe thread sealant.

CAMPAIGN INSTRUCTIONS

1. Contact operating personnel responsible for the fire protection system before starting work. Obtain approval to perform the fuel plumbing modification.
2. Disengage the automatic start switch on the controller.
3. Shut off the fuel supply line to the engine fuel pump.

REFER TO FIGURE 2.4.1.2.3 FOR THE FOLLOWING STEPS:

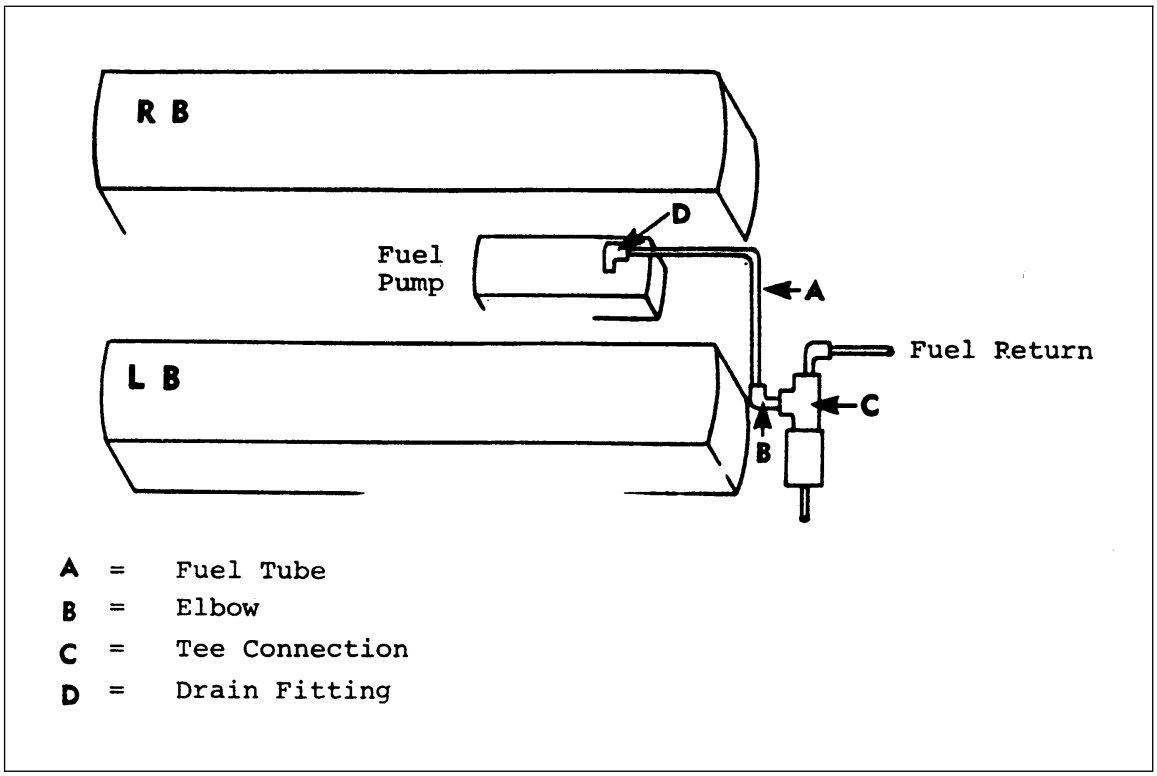

Fig. 2.4.1.2.3 Old fuel return arrangement.

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5. Remove the elbow (Reference B) from the injector return tee connection (Reference C) and plug the tee connection with a ¼ NPTF pipe plug (Reference H, Figure 2.4.1.2.4).

6. Remove the drain fitting (Reference D) from the fuel pump. Install drain elbow, P/N S-1040-A, on the fuel pump return tap.

REFER TO FIGURE 2.4.1.2.4 FOR STEPS 7 and 8

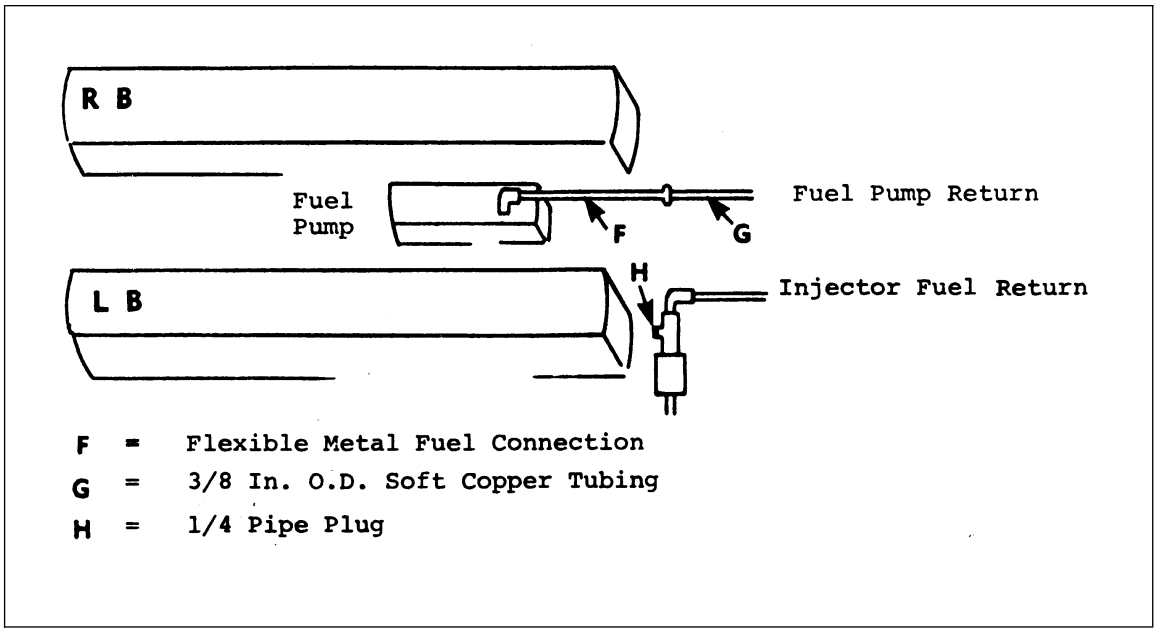

Fig. 2.4.1.2.4 New fuel return arrangement.

7. Install an agency approved flexible metal fuel line connection on the fuel pump drain elbow (Reference F).

8. Install 3/8 in. O.D. soft copper tubing from this flexible metal fuel connection back to the **top** of the fuel supply tank (Reference G). This line must be separate from the injector return line as shown in Figure 2.4.1.2.5.

9. If only one fuel return opening is available at the top of the supply tank, it is permissible to tee connect the two return lines at the top of the tank as shown in Figure 2.4.1.2.6. Do not connect the two return lines at any other location. Make certain that the fuel pump return line is connected below the injector return line as shown in Figure 2.4.1.2.6.

10. Open the fuel supply line to the engine fuel pump.

11. Start and operate the engine at rated speed and check for any fuel leaks. Correct as required.

12. Shut off the engine. Notify operating personnel that the engine is ready for service. Obtain authorized signature of acceptance.

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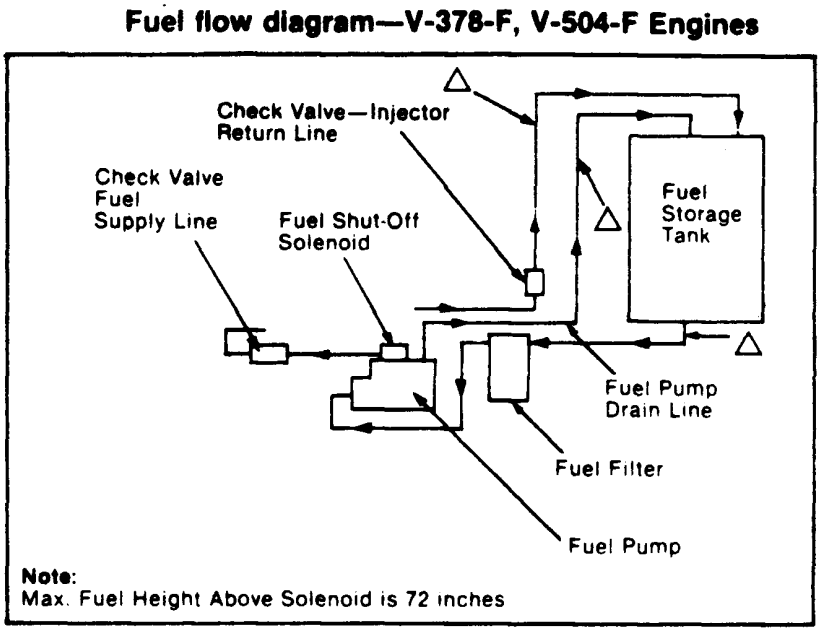

Fig. 2.4.1.2.5 Fuel flow diagram-V-378-F, V-504-F engines.

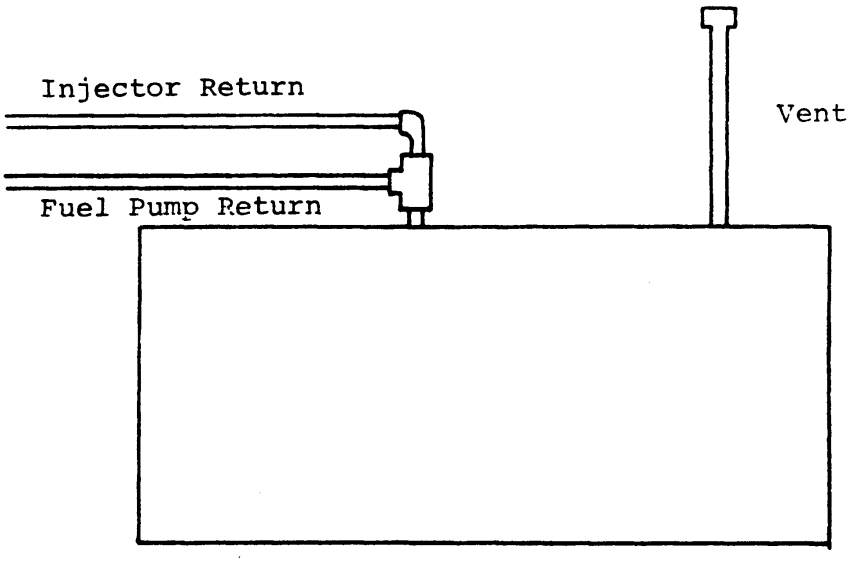

Fig. 2.4.1.2.6 Fuel supply tank.

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2.4.1.3 Cummins Engine Company Models NT855F3; NT855F4; NTA855F; NTTA855F Fire Pump Drive Engines: Cummins Campaign No. 8532.

RECOMMENDATION

Anytime a Model NT855F3, NT855F4, NTA855F, NTTA855F engine driving a fire pump is located, check its serial numbers against those in this data sheet to ascertain whether the recommended modification is needed or has been made.

If the recommended modification is needed and has not been made, the engine should be repaired without delay by a local Cummins distributor under Campaign No. 8532.

DISCUSSION

A limited number of NT fire pump drive engines have been shipped to the field with a possible defective speed switch.

A list of NT fire pump drive engines that may have a defective United Technologies Model SWA 675 speed switch is attached.

The problem is a resistor that does not allow the cranking relay to automatically reset after the engine has been started and shut off. This will prevent automatic restart of the engine unless the speed switch is manually reset after shutoff.

Cummins' policy is that the distributor is responsible for notifying the Original Equipment Manufacturer (OEM) and/or the end user of this campaign.

In some instances, engines are sold to a distributor but shipped from the factory to designations other than the distributor location shown on the lists. A check of the serial number of Models NT855F3, NT855F4, NTA855F, NTTA855F engines against the list included here is necessary.

Note: The following information in Figures 2.4.1.3.1 and 2.4.1.3.2 represents Cummins Campaign No. 8532 literature.

2.4.1.4 Cummins Engine Company Model NT Fire Pump Engines: Field Campaign 8815.

RECOMMENDATION

When a Cummins Engine Company, Inc. Model NT fire pump engine is located, check the serial number with the local Cummins distributor to determine if Field Campaign 8815 applies.

If Campaign 8815 does apply, determine if the recommended modification to the control panel wiring has been completed.

If the recommended modification has not been completed, recommend that arrangements be made with the local Cummins distributor to complete repairs under Campaign 8815 without delay.

DISCUSSION

An unknown number of Models NT-855-F3, NT-855-F4, NT-855-F5, NT-855-F6, NTA-855-F and NTTA-855-F fire pump drive engines have been shipped to the field with incorrect control panel wiring in accordance with an incorrect wiring diagram.

The incorrect wiring can cause the controller to lock-in on a weak battery and prevent the engine from starting.

Engines with serial numbers on the Campaign 8815 list should be checked by a Cummins distributor per Campaign 8815, regardless of age or warranty status.

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CUMMINS ENGINE COMPANY
BOX 3005
COLUMBUS, IN. 47202-3005

ATTN: WARRANTY AND/OR
SERVICE MANAGERS

8532

** CAMPAIGN **

DECEMBER 13, 1985

SUBJECT: NT855F3,F4; NTA855F; NTTA855F SPEED SWITCHES

CAMPAIGN NO.	EXPIRATION DATE	CONTACT
8532	DECEMBER 31, 1986	CAROLYN HIOTT/(812)377-8152

DESCRIPTION

A LIMITED NUMBER OF NT FIRE PUMP DRIVE ENGINES MAY HAVE BEEN SHIPPED TO THE FIELD WITH A DEFECTIVE UNITED TECHNOLOGIES SPEED SWITCH MODEL SWA 675 INSTALLED. THE PROBLEM IS A RESISTOR THAT DOES NOT ALLOW THE CRANKING RELAY TO AUTOMATICALLY RESET AFTER THE ENGINE HAS BEEN STARTED AND SHUT OFF. THIS WILL PREVENT AUTOMATIC RESTART OF THE ENGINE UNLESS THE SPEED SWITCH IS MANUALLY RESET.

ACTION

SUSPECT ENGINES FOR SPEED SWITCH INSPECTION

ENGINE SERIAL NO.	SOLD TO DISTRIBUTOR	ENGINE SERIAL NO.	SOLD TO DISTRIBUTOR
11236335	INDIANAPOLIS	18108441	SINGAPORE
11267439	INDIANAPOLIS	18108442	SINGAPORE
18108716	INDIANAPOLIS	18109609	SINGAPORE
18109543	INDIANAPOLIS	18109610	SINGAPORE
18109550	INDIANAPOLIS	18109605	ARLINGTON
18109704	INDIANAPOLIS	18109859	ARLINGTON
18109719	INDIANAPOLIS	11242627	WELLINBOROUGH, ENGLAND
18109827	INDIANAPOLIS	11246754	WELLINBOROUGH, ENGLAND
18109709	ATLANTA	11232680	DAVENTRY, ENGLAND
18109718	ATLANTA	18109693	COLUMBUS, OH
18109822	ATLANTA	18109838	COLUMBUS, OH
18109823	ATLANTA	18109544	QUEBEC
18109824	ATLANTA	11257647	LOUISVILLE, KY

LOCATE THE SUSPECT ENGINES (SEE ABOVE) AND INSPECT THE SPEED SWITCH TO DETERMINE IF THE CRANK RELAY RESISTOR BETWEEN TERMINALS E1 AND E2 HAS BEEN REMOVED. INSPECT AND REPAIR THE SWITCH (IF REQUIRED) AS FOLLOWS:

THE SPEED SWITCH IS LOCATED INSIDE THE ENGINE INSTRUMENT PANEL. TO INSPECT THE SWITCH, REMOVE THE RUBBER COVER FROM THE FRONT CASE OF THE SPEED SWITCH EXPOSING THE OVERSPEED AND CRANK TERMINATION ADJUSTMENT SCREWS. IN THIS AREA YOU WILL SEE TERMINALS MARKED E1 AND E2. REMOVE THE 110 K RESISTOR BETWEEN TERMINALS E1 AND E2 IF THERE IS ONE. THIS WILL ALLOW THE CRANKING RELAY TO RESET AUTOMATICALLY AND THE SPEED SWITCH WILL FUNCTION CORRECTLY. NO ACTION IS REQUIRED ON SPEED SWITCHES THAT ALREADY HAVE THE RESISTOR REMOVED.

REPLACE THE RUBBER COVER AND CLOSE UP THE INSTRUMENT PANEL.

DISTRIBUTED TO: WORLDWIDE DISTRIBUTORS AND BRANCHES
DIVISION AND REGIONAL OFFICES

Fig. 2.4.1.3.1 Cummins campaign 8532 description.

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8532

IF THE RESISTOR HAD TO BE REMOVED, TEST THE ENGINE TO MAKE SURE IT WILL START AUTOMATICALLY AFTER BEING OPERATED AND SHUT OFF.

IF THE SWITCH REQUIRED NO REPAIR, DO NOT TEST THE ENGINE.

MATERIAL DISPOSITION

SCRAP

REIMBURSEMENT - WITHIN BASE WARRANTY OR OUT OF THE BASE WARRANTY PERIOD

LABOR -- 0.5 PER ENGINE AT THE APPROVED LABOR RATE

PARTS -- NONE REQUIRED

TRAVEL - ACCORDING TO NORMAL WARRANTY GUIDELINES.

CLAIM INSTRUCTIONS

. PAGE TWO OF THE CLAIM MUST BE COMPLETED.

. A MULTIPLE ENGINE SERIAL NUMBER CLAIM MAY BE SUBMITTED.

PAY CODE(1.2.3)(DIST).....X
PAY CODE(1.2.3)(DLR).....D
PAY CODE(1.2.3)(INTL).....I
ACCOUNT CODE(1.2.4).....65

AUTHORIZATION(1.2.5).....8532
SEVERITY CODE(3.2.2).....A
FAILURE CODE(3.2.3).....WVXOSC

Fig. 2.4.1.3.1 Cummins campaign 8523 description (cont'd).

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DATE: May 2, 1986
TO : DIST-D/AL/LOC
DIST-DIV/REG
DIST-NDIV RSM
DIST-Intl
FROM: C.M. Hiott
SUBJECT: 8532A Field Campaign - Speed Switch

CUMMINS ENGINE CO.
BOX 3005
COLUMBUS, IN 47202-3005

TO: Warranty and/or Service Managers
Worldwide Distributors and Branches

****

May 2, 1986 FIELD CAMPAIGN NO. 8532

Amendment A

SUBJECT: NT855F3,F4; NTA855F; NTTA855F Speed Switches

EXPIRATION DATE: December 31, 1986

CONTACT: Carolyn Hiott (812)377-8152

****

DESCRIPTION:

See Campaign 8532 dated December 13, 1986.
See below for added Engine Serial Numbers and locations:

Engine Serial #	Locations	Engine Serial #	Locations
18109566	St. Louis	18109959	CIC
18109716	Edmonton	18109960	"
18109720	Columbus, OH	11308163	"
18109784	" "	11308164	"
18109819	" "	11308165	"
18109820	Tampa, Fl	11315526	"
18109821	" "	11315527	"
18109825	" "	11315528	"
18109826	Korea	11312958	"
18109828	Phoenix	11312959	"
18109940	Columbus, OH	11312960	Edmonton
18109941	Arlington, TX	11312961	Portugal
18109942	Kansas City	11312962	San Francisco
18109943	Atlanta, GA	11312963	CIC
18109946	Indianapolis	11316470	Dedham
18109947	"	11316471	CIC
18109948	"	11308158	Atlanta, GA
18109949	Quebec	11308159	Venezuela
18109950	Columbus, OH	11308160	Atlanta, GA
18109955	Venezuela	11308161	" "
11321398	CIC	11308162	Indianapolis, IN

Fig. 2.4.1.3.2 Cummins campaign 8532 listing.

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11327890	"	11315521	Columbus, OH
11327891	"	11315522	Indianapolis, IN
18109694	"	11315523	" "
18109795	Daventry	11315524	Kansas City, KC
18109829	Indianapolis	11321394	Memphis
18109837	"	11321395	"
18109860	Arlington, TX	11321396	Columbus, OH
18109861	CIC	11321397	CIC
18109862	"	11312960	Edmonton
18109863	"	11312961	Portugal
18109956	"	11316470	Dedham
18109957	"	18109796	Daventry
18109958	"	11315525	CIC
18109860	Arlington, TX	11321396	Columbus, OH

MATERIAL DISPOSITION: Scrap

REIMBURSEMENT - In Base Warranty or out of Warranty

LABOR --- 0.5 hour per engine at the approved labor rate
PARTS --- None
TRAVEL -- According to normal warranty guidelines.

CLAIM INSTRUCTIONS:

- Page two of the claim must be completed.
- A mulitple engine serial number claim may be submitted.

PAY CODE (1.2.3)(Dist).... X
PAY CODE (1.2.3)(Dlr.).... D
PAY CODE (1.2.3)(Intl).... I
PAY CODE (1.2.4)..... 65

AUTHORIZATION NO.(1.2.5)..... 8532
SEVERITY CODE (3.2.2)..... A
FAILURE CODE (3.2.3)..... WVXOSC

Fig. 2.4.1.3.2 Cummins campaign 8532 listing (cont'd).

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2.4.1.5 Cummins Engine Company, Inc. Service Parts Topics 93T8-2; Safety Campaign 9209; Models 6BTA5.9-F1 and 6BTA5.9-F2 Fire Pump Engines (first published September 1993).

RECOMMENDATION

When a Cummins Engine Company, Inc. Model 6BTA5.9-F! and/or 6BTA5.9-F2 engine is located, check that the engine data tag has been stamped ‘‘9209,’’ which indicates the modification has been completed.

If the modification has not been completed, arrangements should be made with the local Cummins distributor to complete the modification under Safety Campaign 9209 without delay.

DISCUSSION

Cummins Model 6BTA5.9-F! and 6BTA5.9-F2 fire pump engines rated 1760 RPM and built before engine serial number 44764160 experience a resonance on belt tensioners which causes premature fan belt failure. Engines rated at 2100 RPM are not affected.

Loss of belt results in overheating, eventually causing the engine to seize and stop. Frequently, engine overheating causes extensive engine damage, even to the extent of engine replacement.

Installation of option EH 9993 (Campaign Kit — Part #3803640) is critical as the belt can fail in the first 25 hours of operation.

The following information in Figure 2.4.1.5.1 from Cummins provides details.

2.4.1.6 Cummins Engine Company, Inc. Fuel Lift Pump; Fire Pump Engines Models 6BTA5.9-F1 and 6BTA5.9 (first published July 1993).

DISCUSSION

The following is for information only. No action is required.

Cummins Engine Co. requested and received FM Approval to allow engine distributors to add a fuel lift pump to engines, where required. If the fuel lift pump is required after the engine is shipped from the factory the distributor may install it in the field without violating approval. More and more areas throughout the country are requiring the fuel tank installed on the ground instead of elevated as recommended in Data Sheet 3-7N and NFPA 20. This requires the addition of a fuel lift pump.

Option FS 9025 includes the parts necessary for installation of the fuel lift pump.

Part Number	*Description*	*Qty.*
3281476	Screw, Banjo Connector	1
3900631	Capscrew	2
3914284	Spacer, Mounting	1
3914304	Gasket, Cover Plate	2
3914753	Tube, Fuel Supply	1
3918000	Pump, Fuel Transfer	1
3918191	Washer, Sealing	2

4.0 REFERENCES

1. NFPA 20, ‘‘Standard for the Installation of Stationary Pumps for Fire Protection’’, 1999 edition.

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Service Parts Topics

Date: May, 1993
No.: 93T8-2
File Group: 08
Engine Family: B Series

Subject
New Belt Drive For 6BTA F1 and F2 Fire Pump Engines

Troubleshooting & Repair Manual	Shop Manual	O/M Manual	Alternative Repair Manual	Specifications Manual	Other
		3810374-01			

A new Front Drive Option, **EH9993**, has been introduced for the 6BTA F1 and F2 Fire Pump Drive engines.

This new front drive arrangement has been released to stop belt slippage and squealing resulting from high alternator loads and belt slipping resulting from belt tensioner resonance. This option can be retrofitted to existing engines in the field with the addition of a new belt guard , **Part Number 3921751,** or modifying the existing belt guard.

The new belt arrangement option **EH9993** contains the following:

Part Number	Quantity	Description
3900635	1	Screw, Hex Flange Head
3901445	1	Screw, Hex Flange Head
3903095	2	Screw, Flat Head Cap
3904446	1	Screw, Hex Flange Head
3911587	1	Belt, V Ribbed
3920541	1	Bracket, Belt Tensioner
3921533	1	Shield, Dust
3921988	1	Shaft, Idler
3922900	1	Tensioner, Belt
3922982	1	Pulley, Idler

This option has become standard for the 6BTA F1 and F2 engines after engine serial number **44764160**.

Cummins Engine Company, Inc., Columbus, Indiana 47202-3005
Cummins Engine Company, Ltd., Daventry, Northants, England NN11 SNU
Registered Office: 46-50 Coombe Road New Malden, Surrey KT3 4QL
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Fig. 2.4.1.5.1 Cummins campaign 9209 details.

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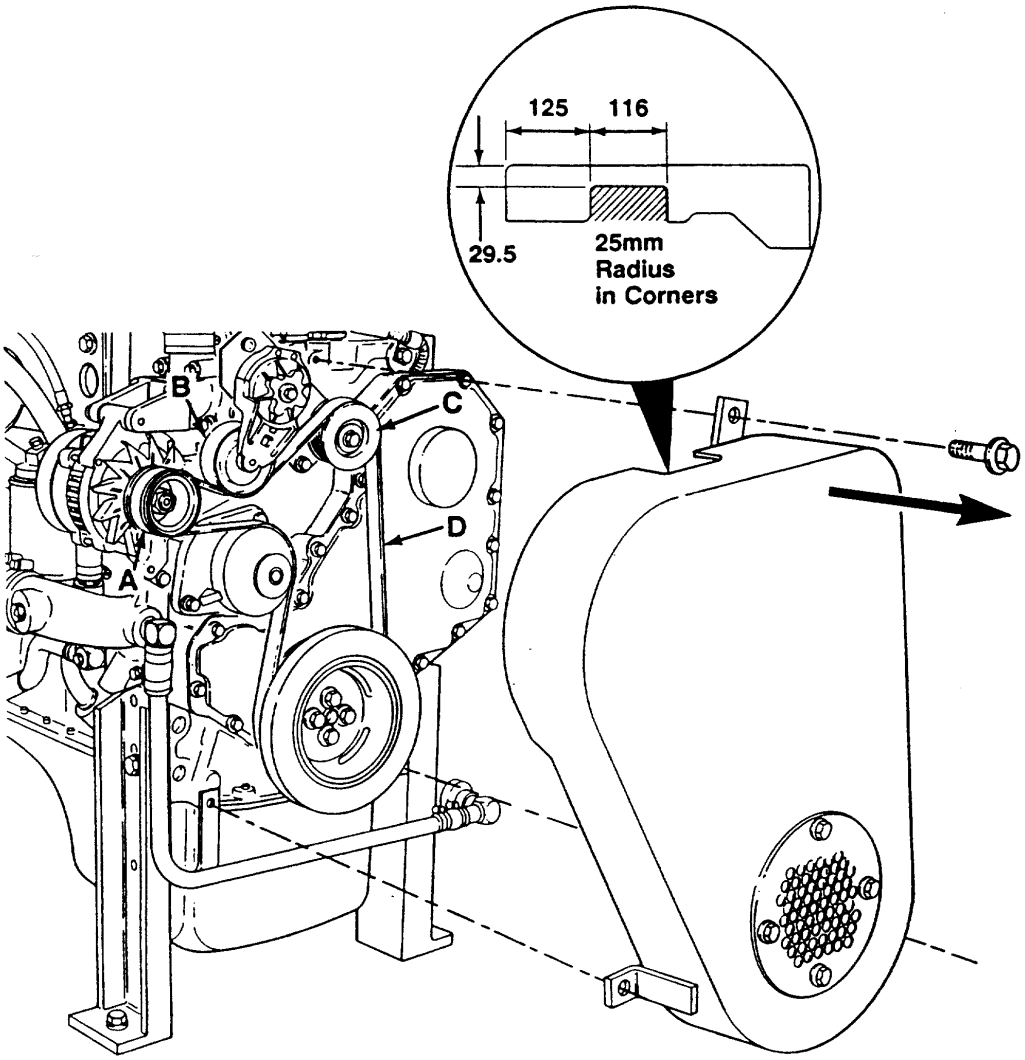
If the new option is installed on an engine presently in service and the existing belt guard cannot be removed, modify the belt guard as shown in the illustration to allow clearance for the new belt tensioner.



A. Alternator Pulley
B. Tensioner Pulley
C. Idler Pulley
D. Belt

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Fig. 2.4.1.5.1 Cummins campaign 9209 details (cont'd).

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